

**M e m o r a n d u m**

Date : July 15, 1998

To : Dave Bogener

From : Curtis Anderson  
Department of Water Resources  
Subject: Antelope Lake Bathymetric Survey

Per your request, the Engineering Studies Section has completed the bathymetric survey of Antelope Lake. This project was a resurvey of the 1989 bathymetric survey performed by the Geology Section, which was supervised by Jack McMillan. Most of the cross sections that were surveyed in 1989 were resurveyed June 10-19, 1998. We were unable to resurvey cross sections IC1, IC2, and L1 because the water was no longer deep enough for the boat. Each of the 1998 cross sections were surveyed at least twice to provide a check on the echosounding data. Cross sections A2 and L2 were the only cross sections that did not have duplicate data due to echosounder problems during the second data collection pass. This memo describes our survey procedure and preliminary results.

From a boat, we used a Knudsen Engineering 320 BP survey grade echosounder to determine water depth to the bottom of the lake. This echosounder has both a 200 kHz and 28 kHz frequency to provide an independent check on the bottom depth. After calibrating the echosounder with both frequencies, we only used the 200 kHz high frequency channel due to its ability to define the bottom better than the low frequency. We performed a daily calibration of the echosounder prior to any data collection using a steel plate suspended below the boat. We lowered the 40 pound 1.5 foot square steel plate under the transducer to a depth of five feet below the water surface. The draft on the echosounder was adjusted until it output a depth of 5 feet. Then the steel plate was lowered to a depth of fifty feet directly under the transducer and the speed of sound setting on the echosounder was adjusted until the depth read exactly fifty feet. Once again we would check the plate at five feet and make sure the draft was still correct.

The position of the echosounder was calculated using a survey grade Global Positioning System receiver in Real Time Kinematic Mode. This provided a real time update of the horizontal and vertical position of the echosounder to a precision of two centimeters. The GPS data points were recorded in both North American Datum 83 Latitude and Longitude, and NAD 83 State Plane (feet) coordinates. The coordinates were based on a rebar monument that Charles Mussett from Precise Surveys gave us (N 311963.64 E 2389294.61 Elev. 5025.013 feet). For GPS base

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station coordinates we converted Mossett's NAD27 state plane zone 1 coordinates to NAD83 latitude and longitude coordinates ( $40^{\circ} 10' 51.9137922''N$  $120^{\circ} 36' 27.937438''W$ ). Each day before the start and after the end of the survey data collection, the reservoir staff gage at the dam spillway was recorded. During the survey, we made sure that the water surface elevation the GPS receiver in the boat was outputting matched the staff gage reading we recorded earlier.

The software used to collect the data was Coastal Oceanographics Hypack version 8.1. This software collected the echosounder along with the GPS data and combined into an X,Y,Z position. The data collection rate was set to collect a data point every 0.5 seconds. The Hypack software also allowed us to digitize the 1989 cross section alignments that were previously surveyed, and displayed them on the computer screen with a real time position of the boat. This real time display of our position allowed us to track the location of the boat in relation to the previous survey lines. If the boat drifted more than thirty feet off the alignment while collecting cross section data, we would stop the data collection, and start that cross section again. We tried to maintain a constant speed of four miles per hour during the data collection process.

Once all of the cross sections had been surveyed twice, we spent one day collecting additional data from locations not on the 1989 cross sections to create a topographic map. Due to time constraints we were only able to concentrate the data collection on the Indian Creek-Boulder Creek arm, Lone Rock Creek arm, and the area near the dam. The boat was driven in a grid pattern to collect data points for the creation of this topographic map.

Once the fieldwork was completed, the data was brought back to the office where it was edited in the Hypack editing program. This program allowed us to remove any bad echosoundings or correct any erroneous GPS data. These bad echosoundings would appear periodically during the data collection as an abnormal depth. An example of a bad depth would be the echosounder reading 8.1',8.3',8.3',1.5',8.5',8.6'. In this example the 1.5' depth would be edited out. The data would most commonly need to be edited in areas where there was thick aquatic vegetation on the bottom of the lake. There were many data spikes caused by erroneous readings off the vegetation that required additional editing.

There were a few cross sections where the GPS receiver had trouble staying in RTK mode. RTK surveying requires that at least four satellites be observed at all times. Once the GPS unit loses lock with at least four satellites due to an obstruction such as a tree, the GPS receiver switches from RTK mode to differential

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mode. While RTK mode is precise to two centimeters, differential mode is only accurate to one meter. To return to RTK mode we had to drive the boat back out from under the obstructing trees, and allow the receiver to reinitialize for about two minutes. Most of the time we were able to determine when we lost RTK mode, however, there were a few times when data was collected in differential mode. To correct this data, the water surface elevation based on the spillway staff gage was added to the differential horizontal position. The Hypack editing program used this manual water surface elevation instead of the GPS derived elevations. The differential horizontal position was used when RTK was lost if the data points fit the cross section adequately.

The cross sectional data from the 1998 survey was input into a spreadsheet program and plotted. For comparison purposes, we tried to printout the new plotted cross sections so they were at the same scale as the 1989 report plots.

The total number of data points collected was approximately 22,000. Due to the large number of points, the Hypack sorting program was used to eliminate points closer than 20 feet. This reduced the total number of points down to 6,000. This edited set of data points was brought into the Softdesk engineering software program where they were used to create a Digital Terrain Model of the lake bottom. From the DTM a two foot contour interval topographic map of the bottom of the lake was created. A copy of that map is attached to this memorandum.

We compared the 1998 surveyed cross sections to the 1989 cross sections to determine changes in the cross sections. This comparison is very rough because the 1989 raw data are not currently available. By scaling distances off of the 1989 cross section plots and comparing them to the 1998 data we calculated that 300,000 cubic yards of sediment has been deposited in Antelope Lake since the 1989 survey. Using the same value of 90 pounds per cubic foot of sediment that was used in the 1989 report, this 300,000 cu. yd. translates to 365,000 tons. This gives an average value of 40,500 tons of sediment per year, which matches the value of 40,000 tons per year in the 1989 report. There were 77,000 cu. yd. deposited in the upper arm of Indian Creek near the Boulder Creek campground. It appears that the main load of sediment is just upstream of cross section IC6. There were also 50,000 cu. yd. deposited in the upper arm of Lone Rock Creek near the Boulder Creek campground. It appears that the main load of sediment is just upstream of cross section L4. The cross sections located near the dam (IC13 and A12) do not show any significant amount of change since the previous 1989 survey. This indicates that currently Antelope Lake does not have a problem with sediment deposition near the dam.

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The Antelope Creek arms of the lake do not appear to be filling in with sediment at this time. Cross section A7 has an increase of 222 cu. yd. of sediment since the 1989. This relatively large change may be a problem with either our survey or the survey done in 1989. I am wary of this 222 cu. yd. difference between the two surveys because cross sections A6 and A8 which are on either side of cross section A7 do not show a significant change. If sediment was coming into the lake from Antelope Creek, then cross section A6 should have more sediment deposition than cross section A7. This is not the case, so there may be a problem with the comparison between the two surveys.

We also ran a data line parallel to the face of the dam with both echosounder frequencies turned on. We did this cross section to see if the low frequency would output a lower depth than the high frequency. If the low frequency indicated deeper readings, that would indicate a layer of unconsolidated fine sediment was settling at the base of the dam. Our cross section did not detect any unconsolidated fine sediments depositing near the dam face. I have included a print out of the two separate plots from this one cross section.

Antelope Lake continues to receive sediment from its upper watershed tributaries, which is potentially impacting recreational facilities. Eventually campers may not be able to park their boats next to their campsite due to the deposition of sediment around the Boulder Creek Campground. Therefore, Department of Water Resources should continue monitoring this incoming sediment by performing a bathymetric survey of Antelope Lake on a regular basis.

The following people worked on this project, Curtis Anderson, Associate Engineer W.R.; Jim West, Assistant Land Surveyor; Jason Jurrens, Student Assistant E&A; David Elkins, Student Assistant; and Darrin Doyle, Fish and Game Aide.

Attachment

Figure 1

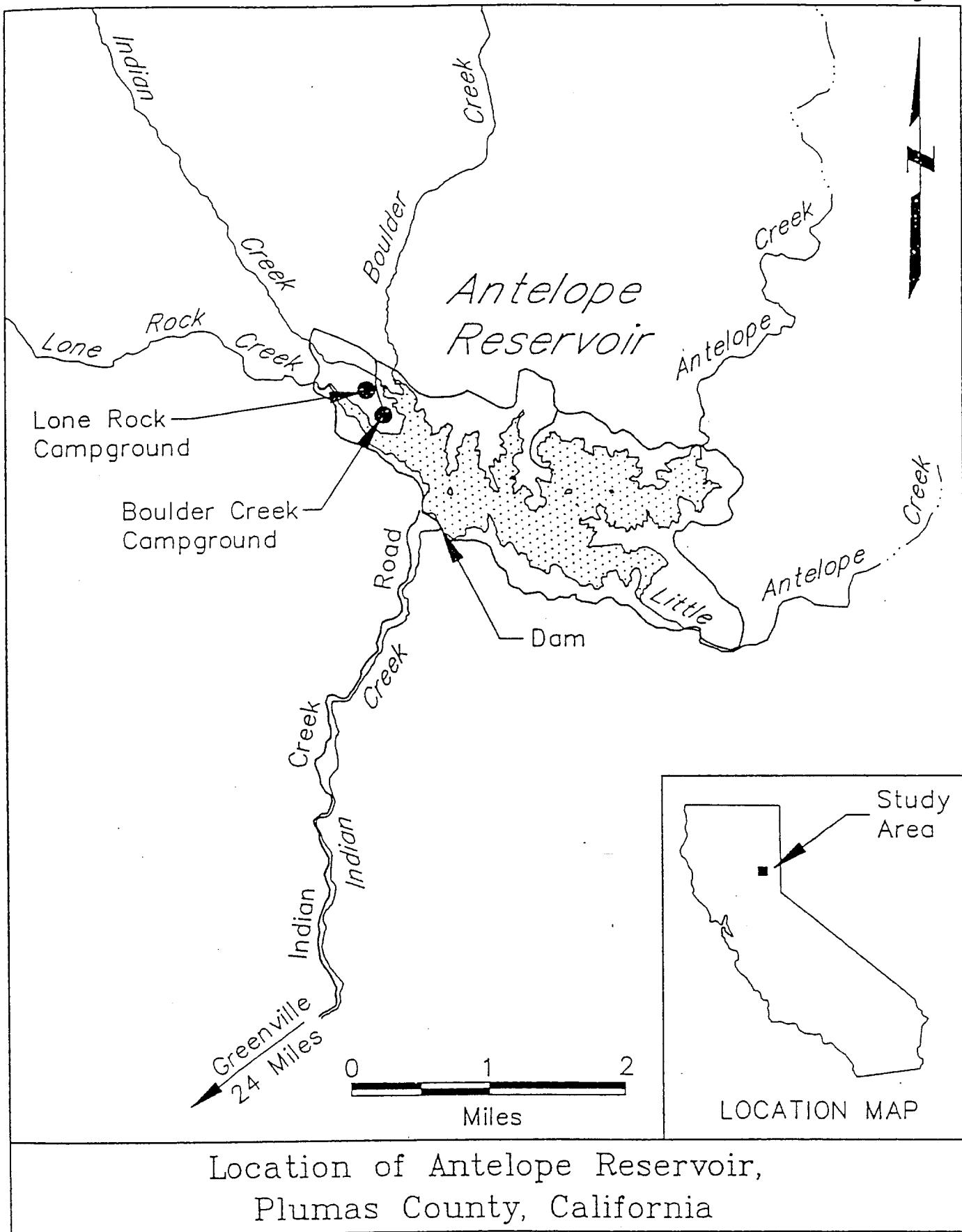
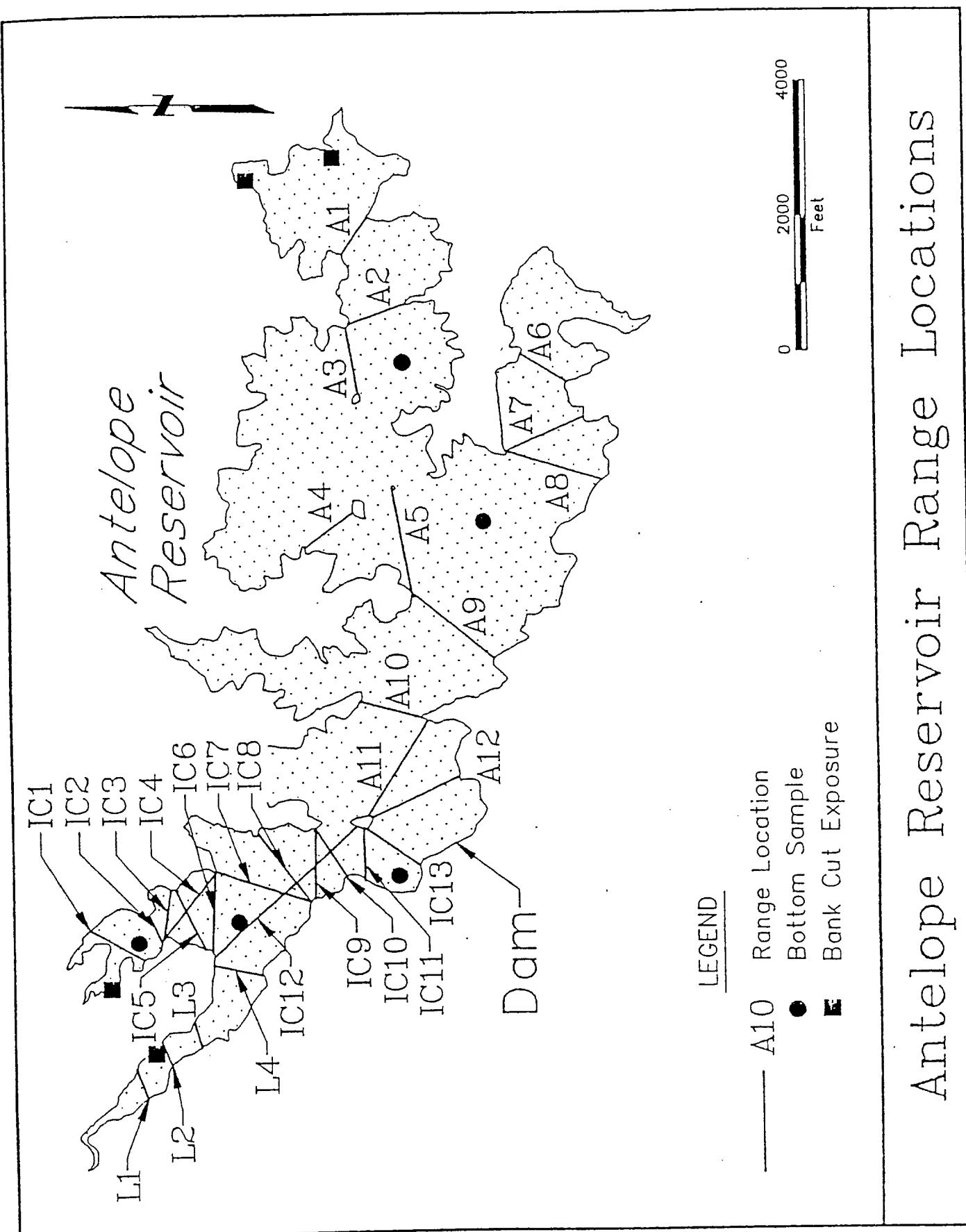


Figure 2



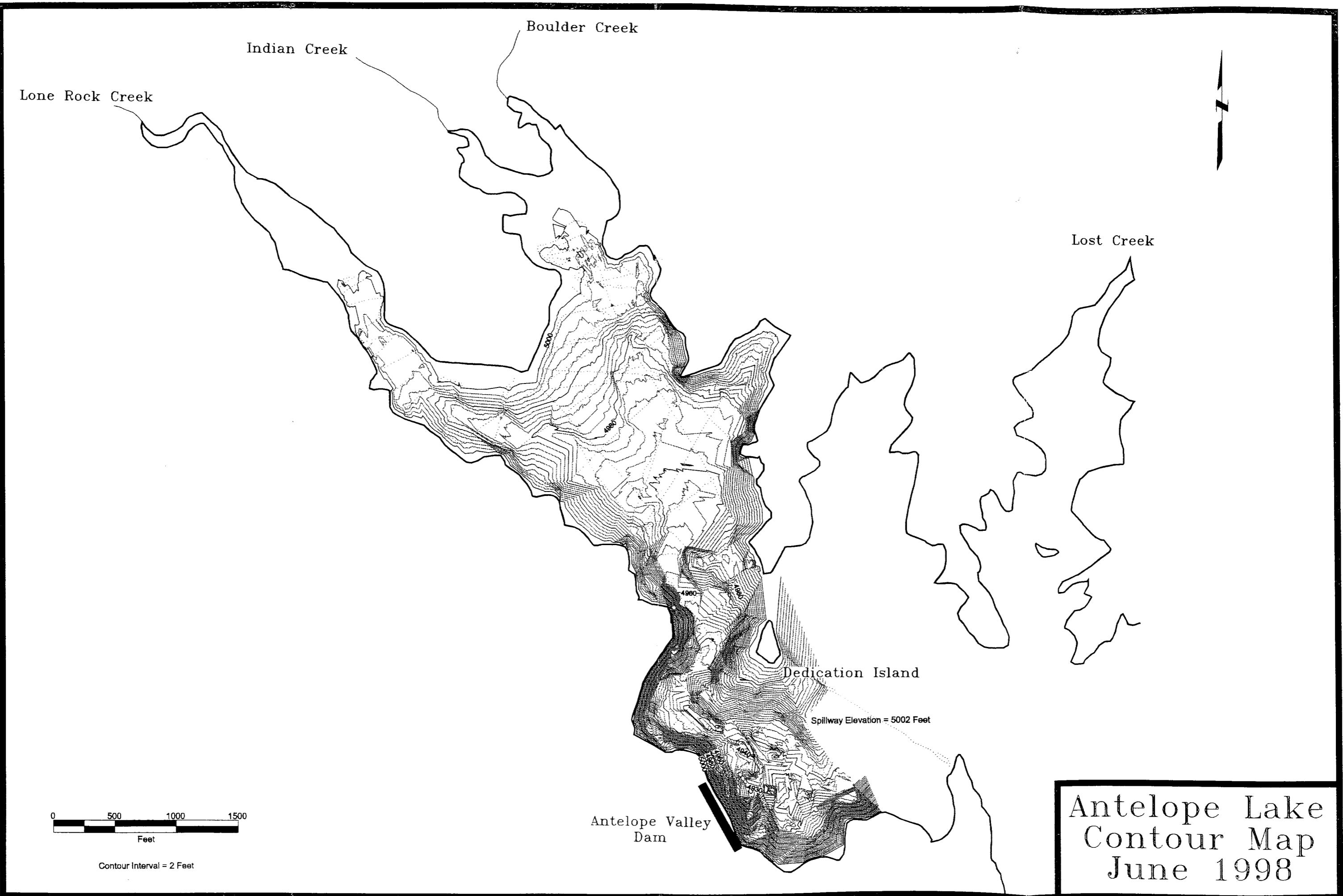
Antelope Reservoir Range Locations

## **Antelope Lake Cross Sectional Sediment Deposits Changes Between the 1989 and 1998 Survey**

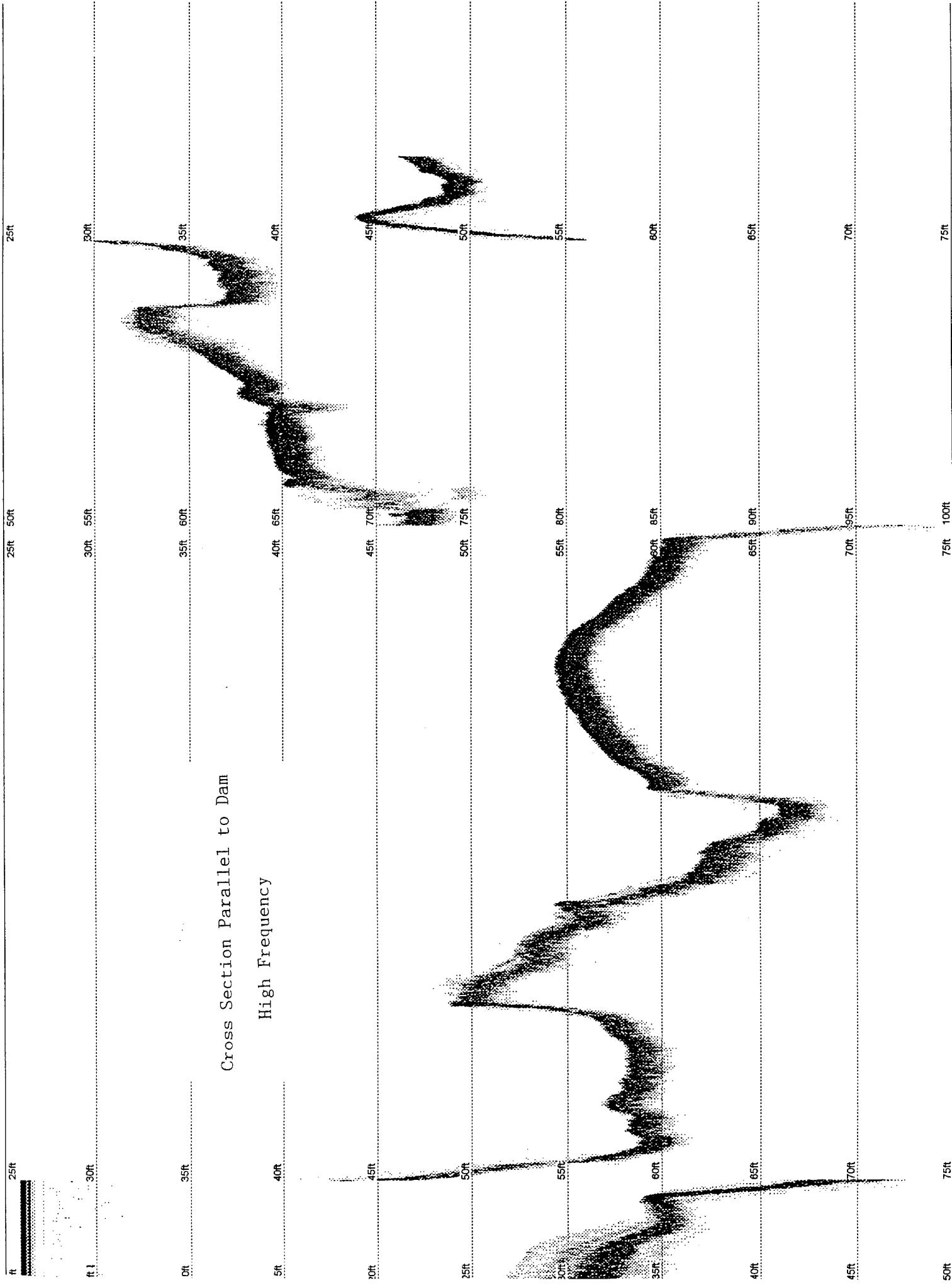
<u>Line</u>	<u>Fill (sq. yds)</u>
A1	44
A2	33
A3	22
A4	50
A5	22
A6	67
A7	222
A8	67
A9	33
A10	42
A11	67
A12	17
IC3	67
IC4	267
IC5	667
IC6	272
IC7	178
IC8	200
IC9	0
IC10	44
IC11	111
IC12	267
IC13	0
L2	67
L3	100
L4	69

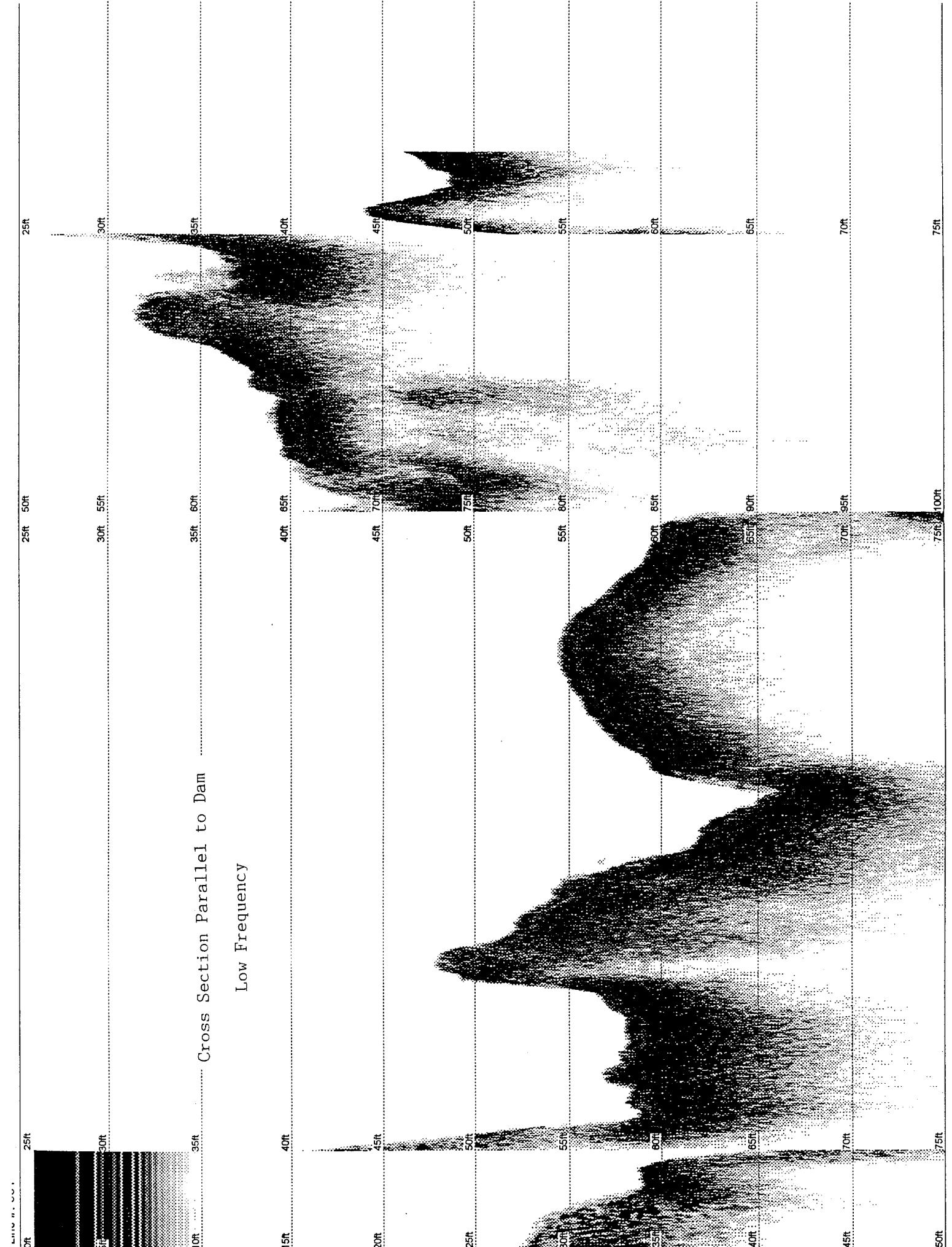
## Antelope Lake Drainages Sediment Deposition Changes Between the 1989 and 1998 Survey

Cross Section	Change (sq. yds.)	Angle	Horizontal Dist. (ft.)	Total Fill (cu. yds)	Drainage
A1	44		1133	<u>14,687</u>	Antelope Creek
A2	33				
A6	67		1038	<b>49,978</b>	
A7	222		512	<b>24,652</b>	
A8	67		<u>SUM =</u>	<u>74,630</u>	Little Antelope Creek
A9	33		1500	<b>18,750</b>	
A10	42		1100	<b>19,861</b>	
A11	67		512	<b>7,111</b>	
A12	17		<u>SUM =</u>	<u>45,722</u>	
				<u>135,039</u>	Total Antelope Creek
IC3	67	67			
IC4	267	52	300		
AVE IC4&IC5	399			<b>23,038</b>	
IC5	667	62	480	<b>53,728</b>	
IC6	272		<u>SUM =</u>	<u>76,766</u>	Indian Creek
L2	67		560	<b>15,556</b>	
L3	100		1166	<b>32,929</b>	
L4	69		<u>SUM =</u>	<u>48,484</u>	Lone Rock Creek
IC8	200		712	<b>29,007</b>	
IC10	44		968	<b>7,170</b>	
IC13	0		<u>SUM =</u>	<u>36,178</u>	Indian Creek
				<u>161,428</u>	Total Indian & Lone Pine Creek
			<u>TOTAL =</u>	<u>296,467</u>	



Line # 001

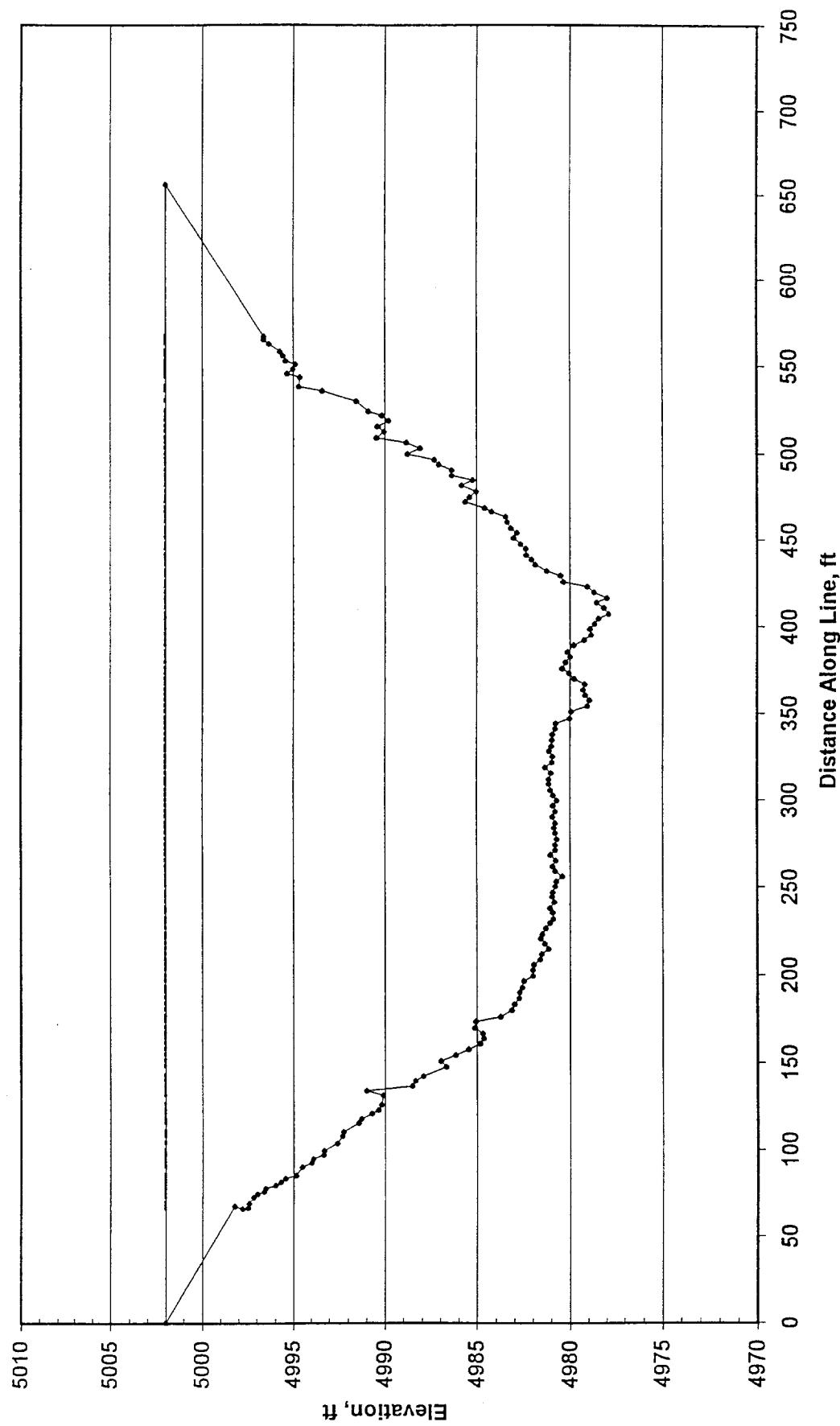




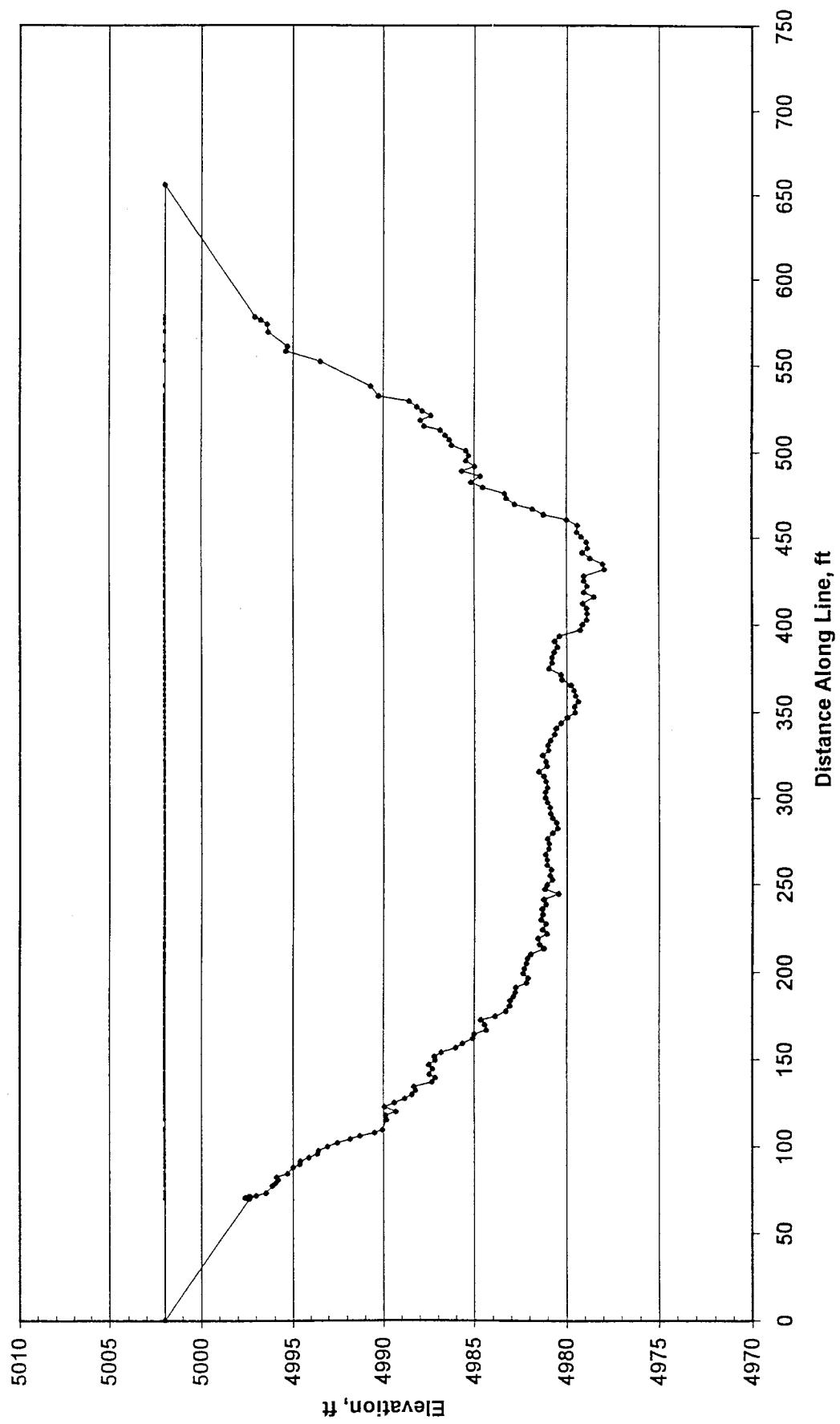
# **Cross Section Plots**

## **1998 Survey**

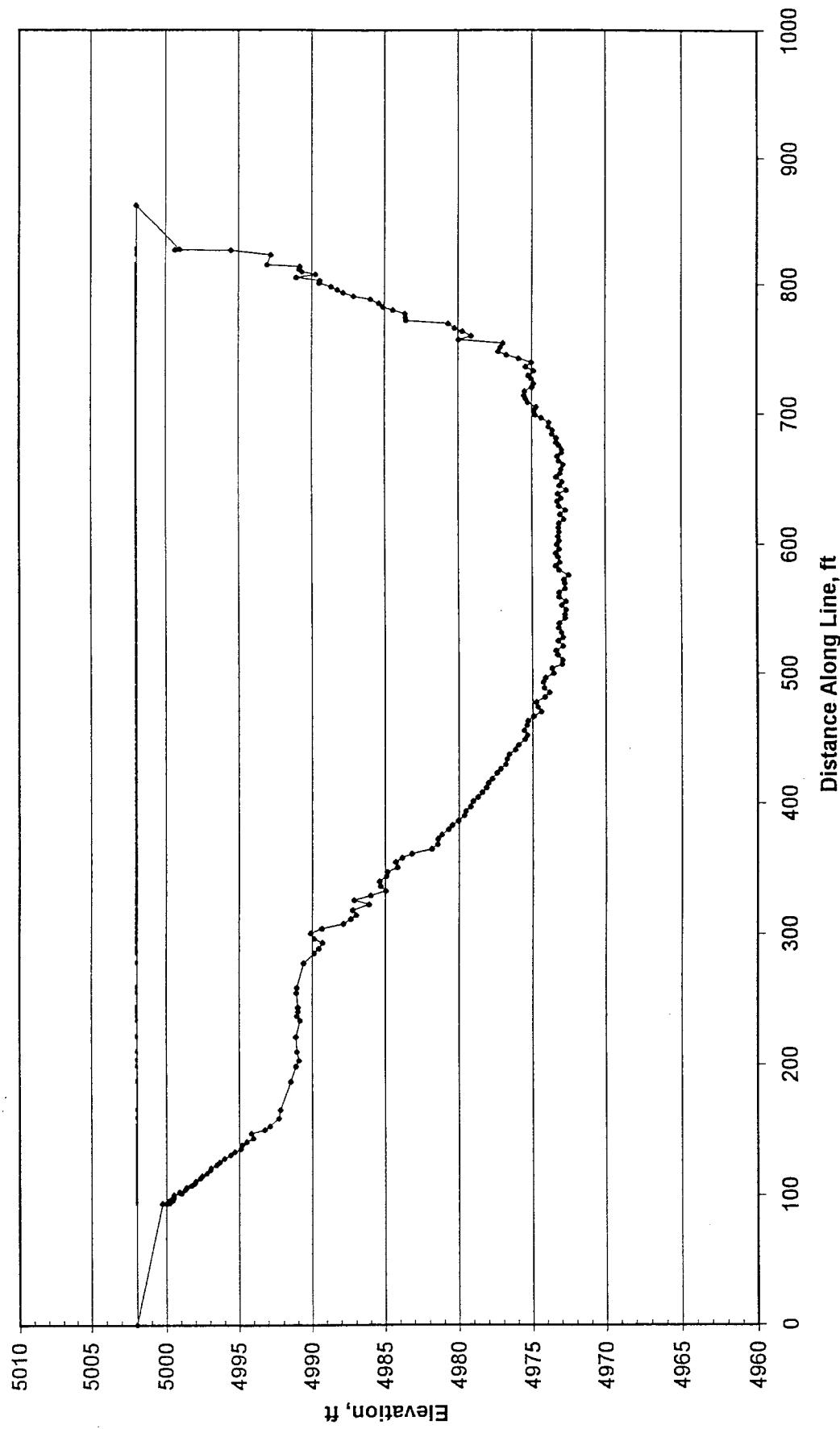
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Northwest-->Southeast



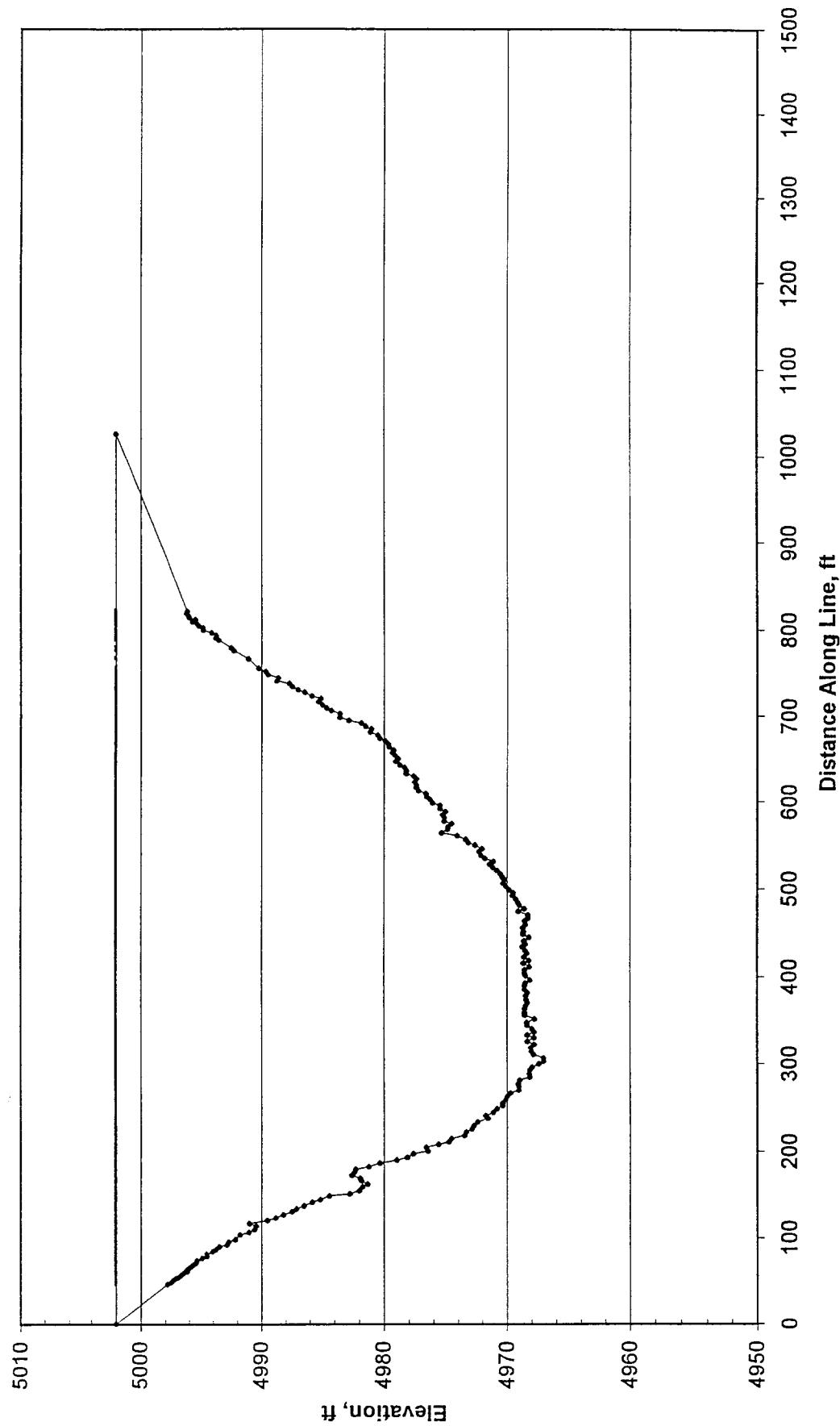
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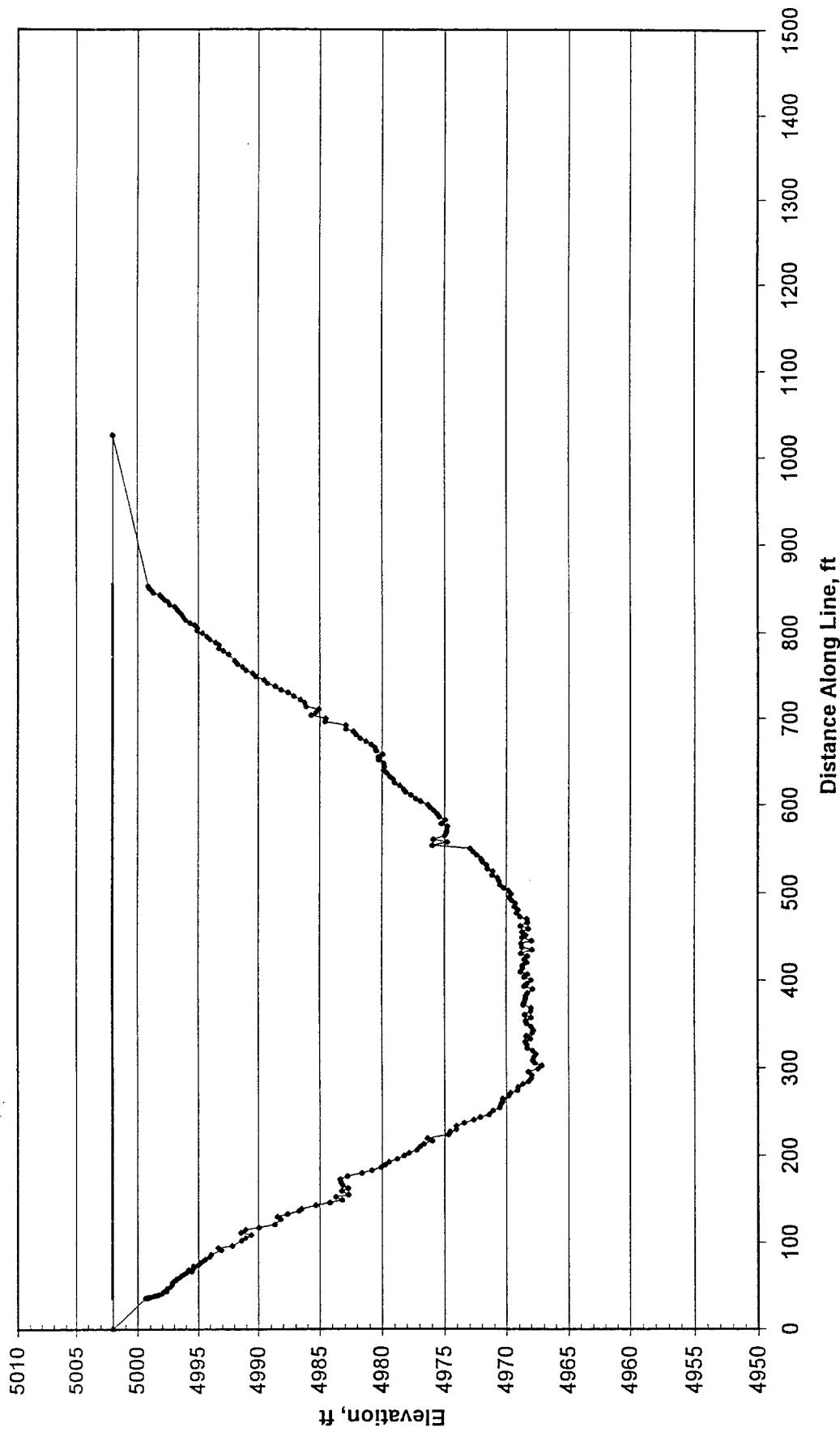
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North--->South



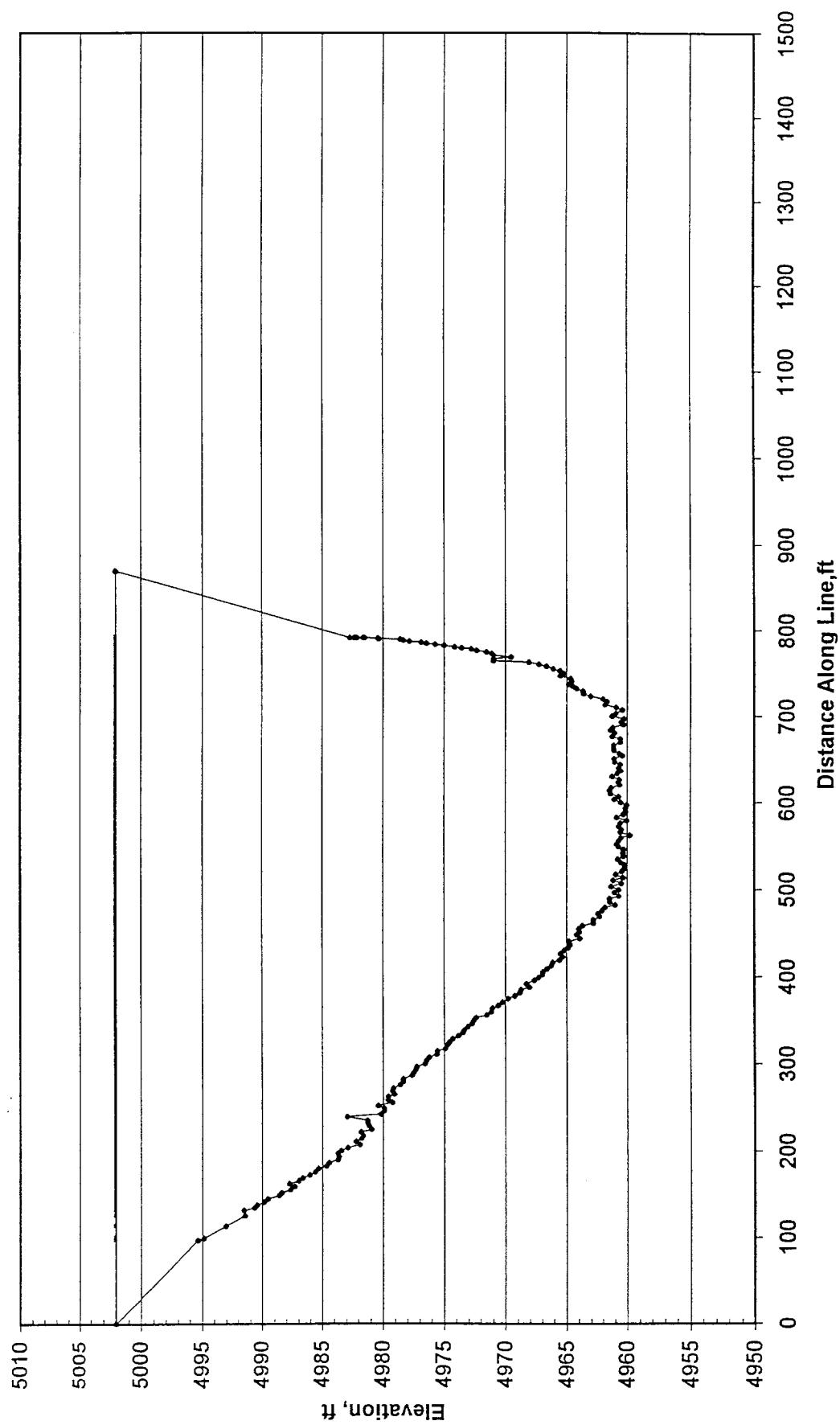
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West-->East



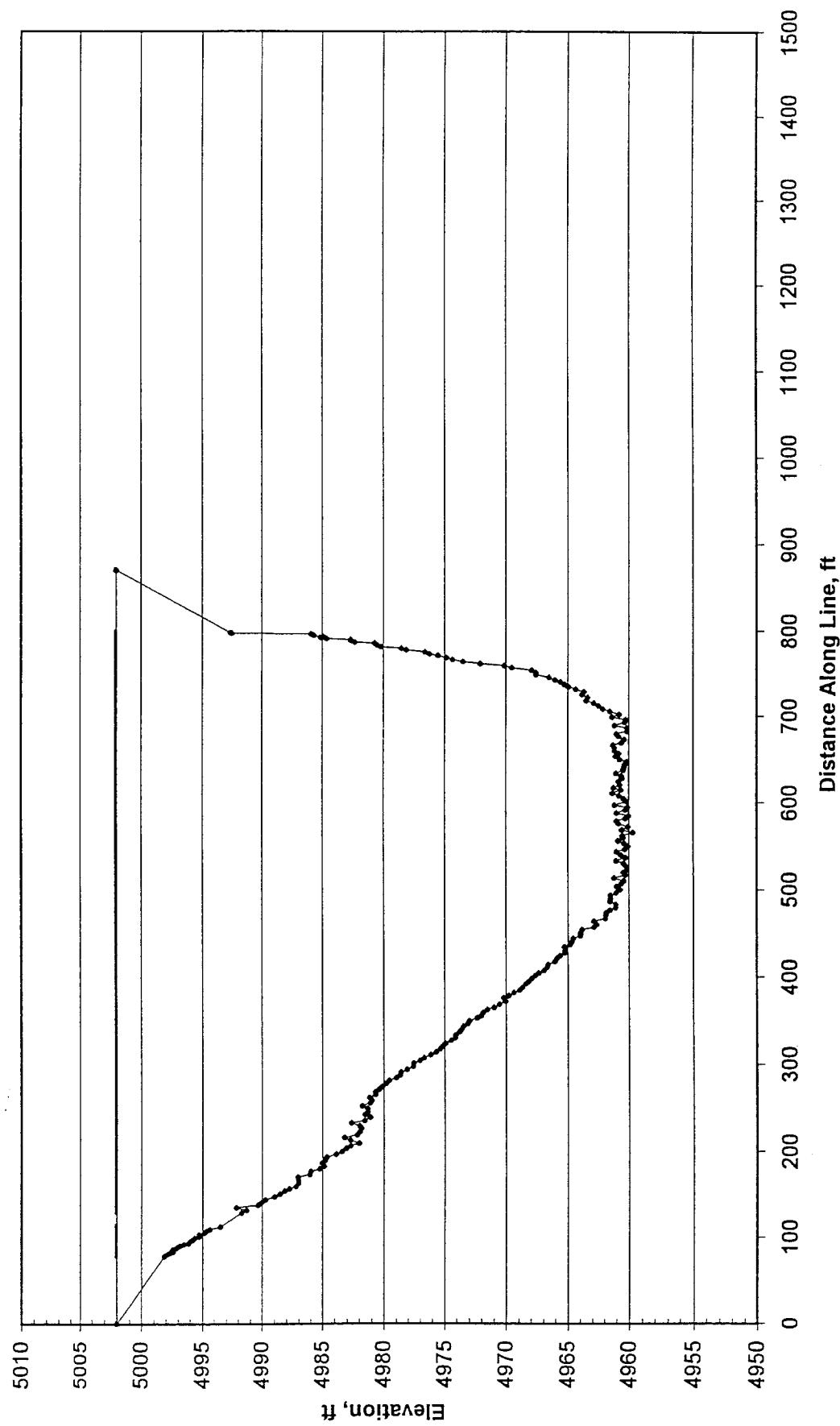
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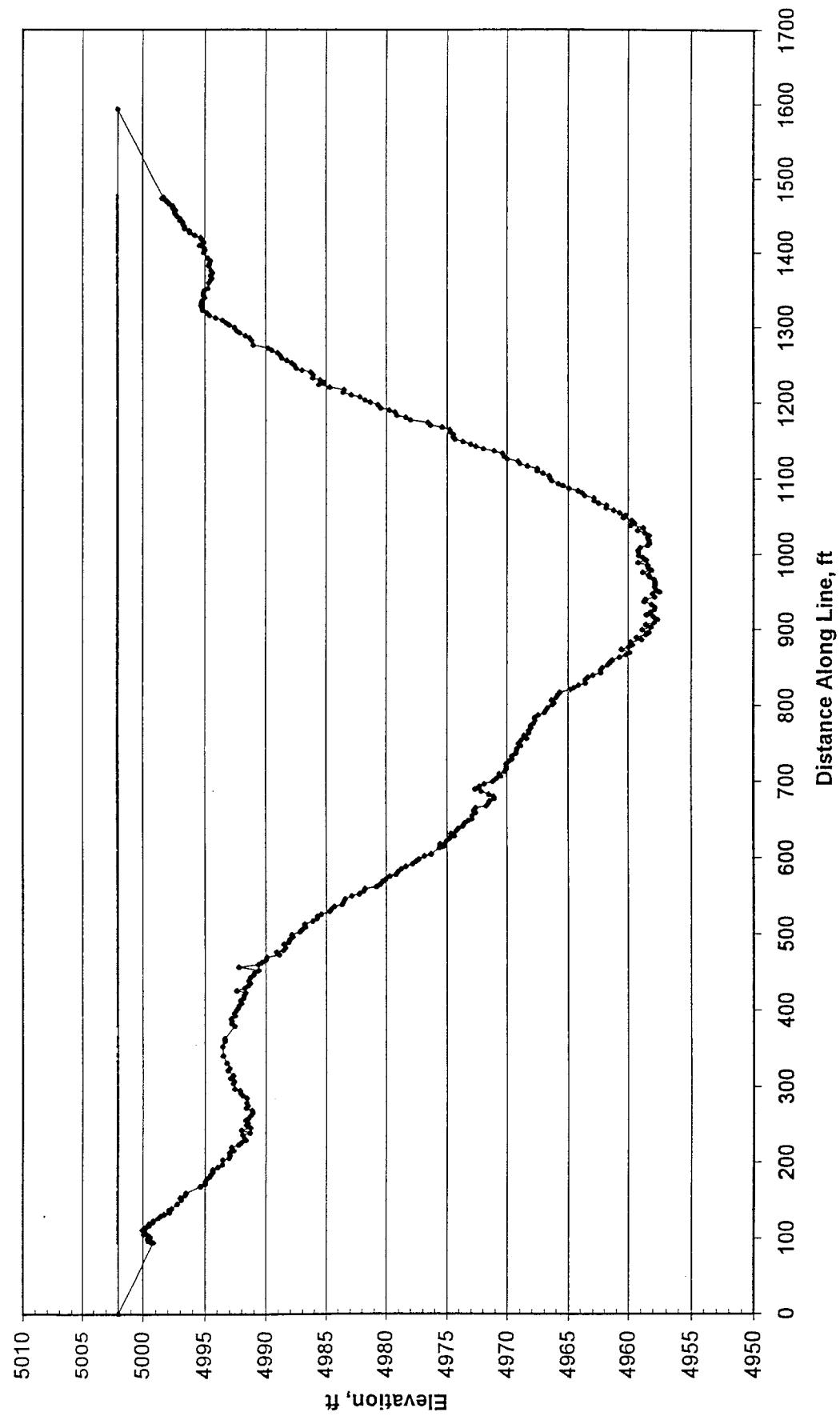
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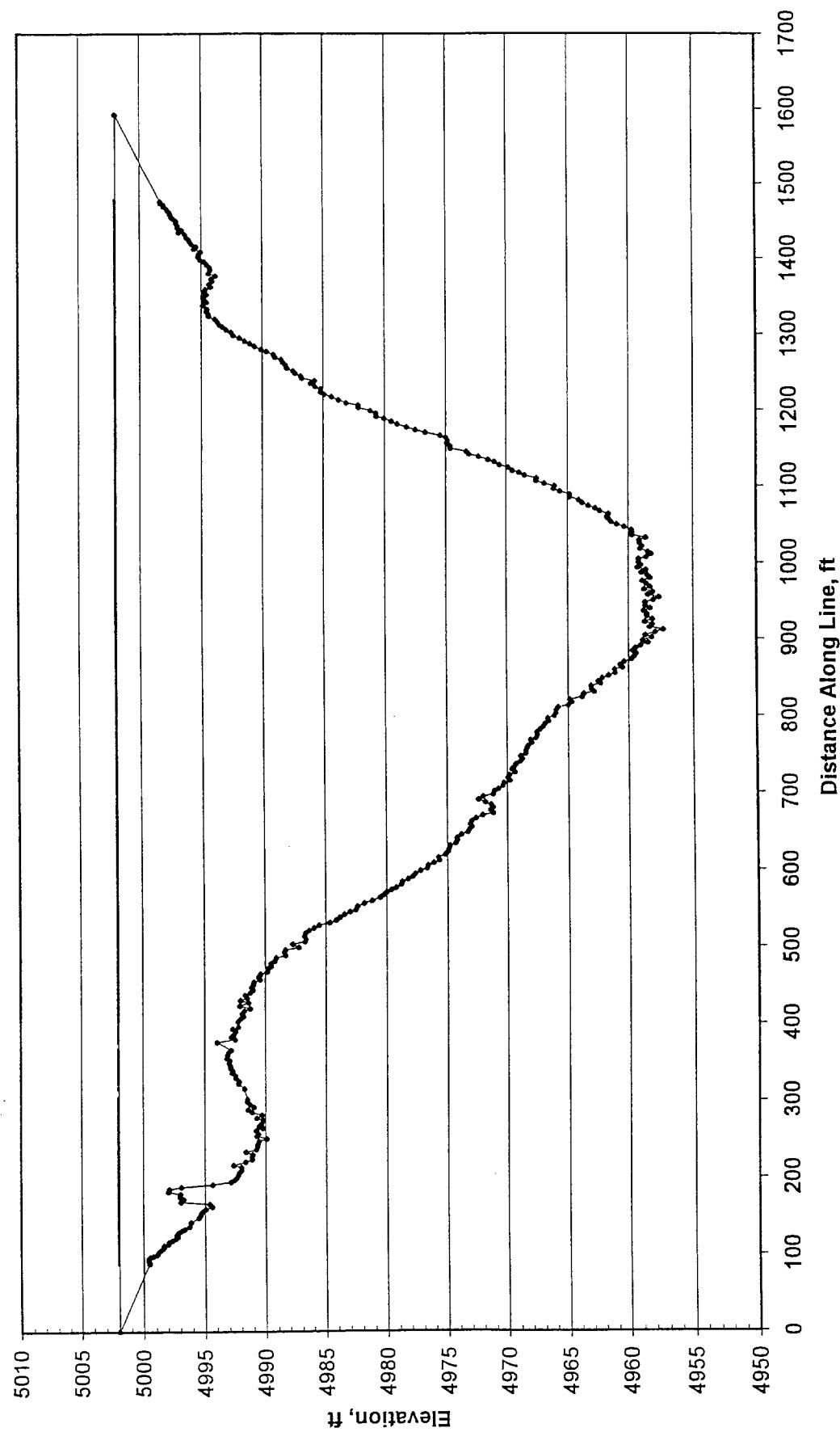
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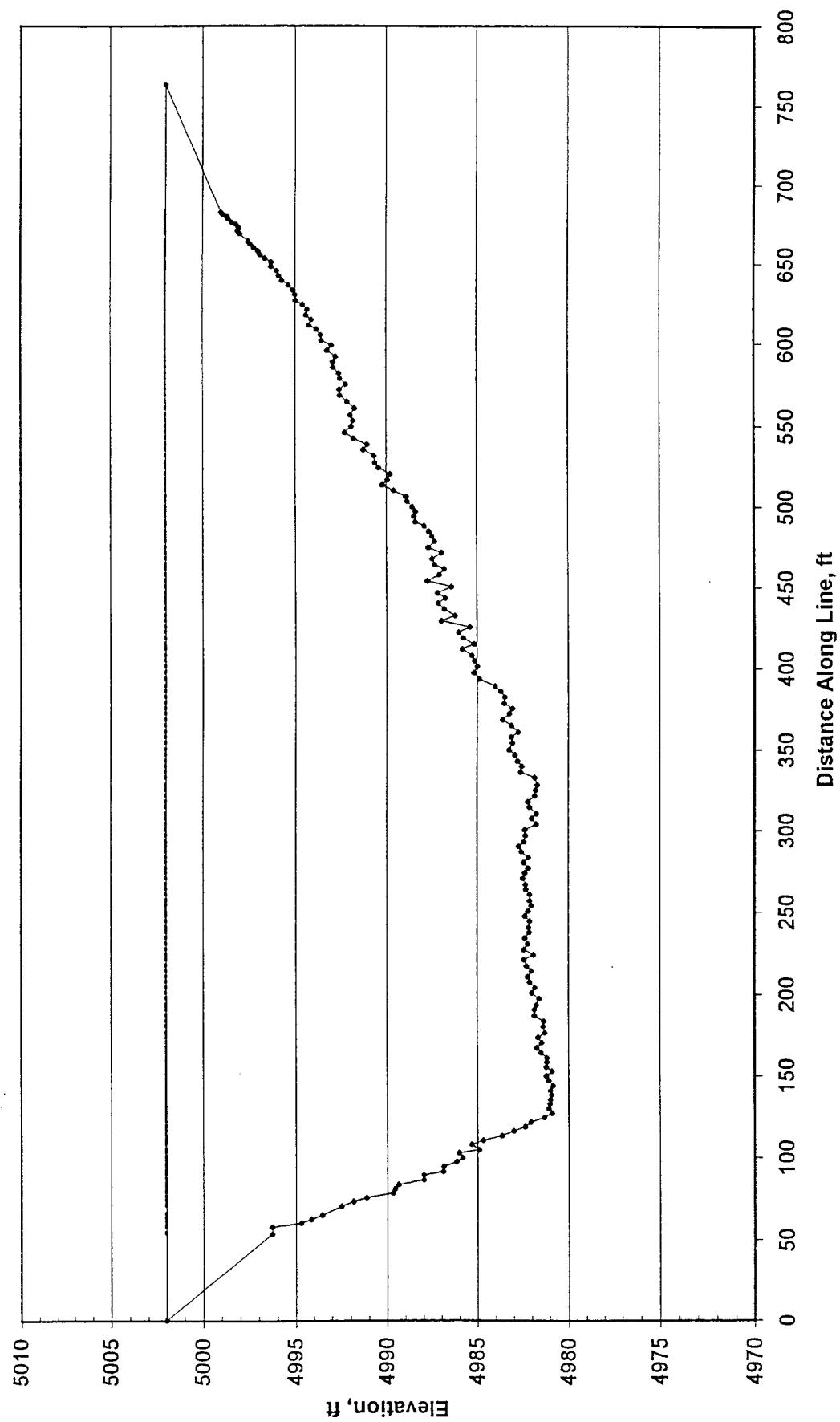
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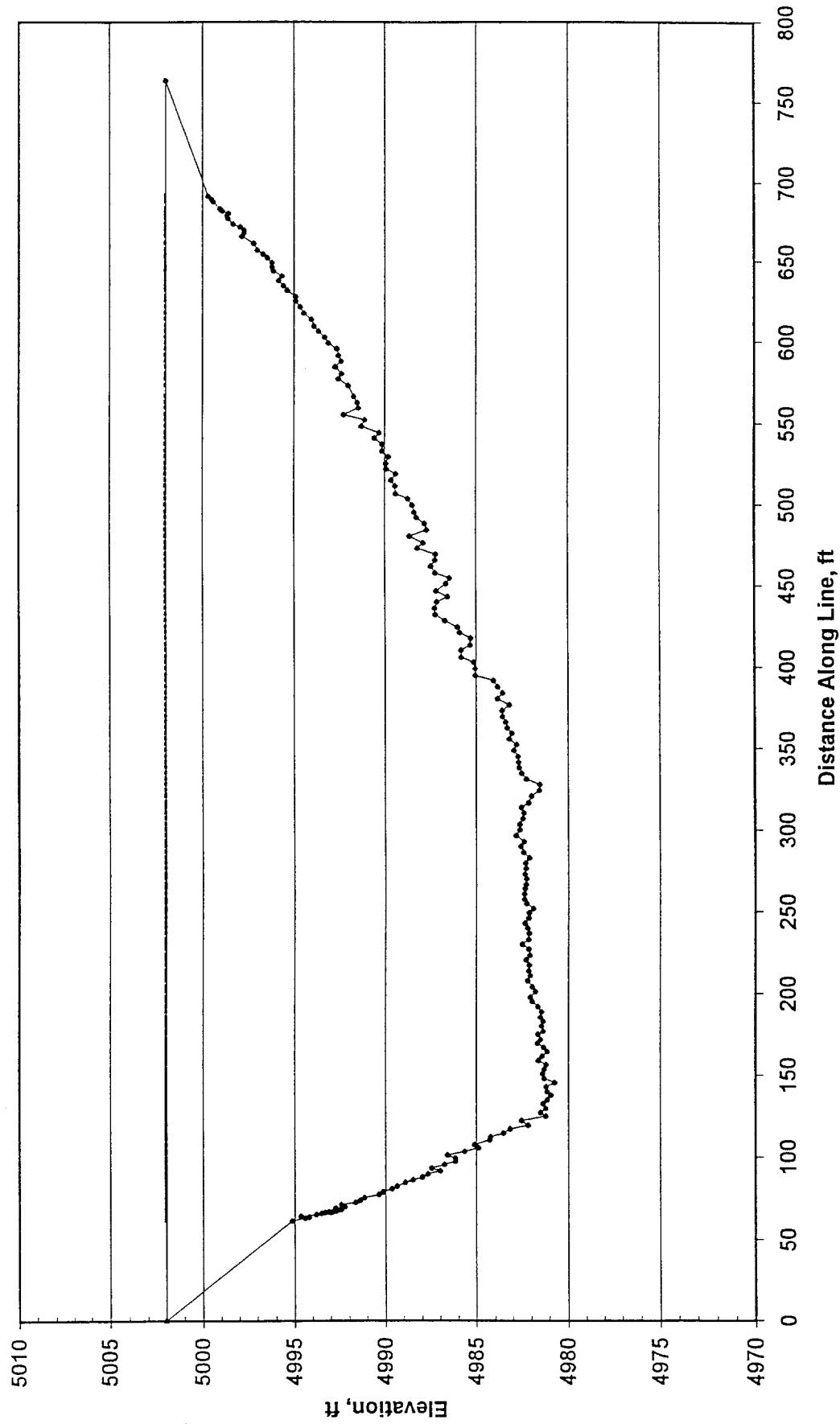
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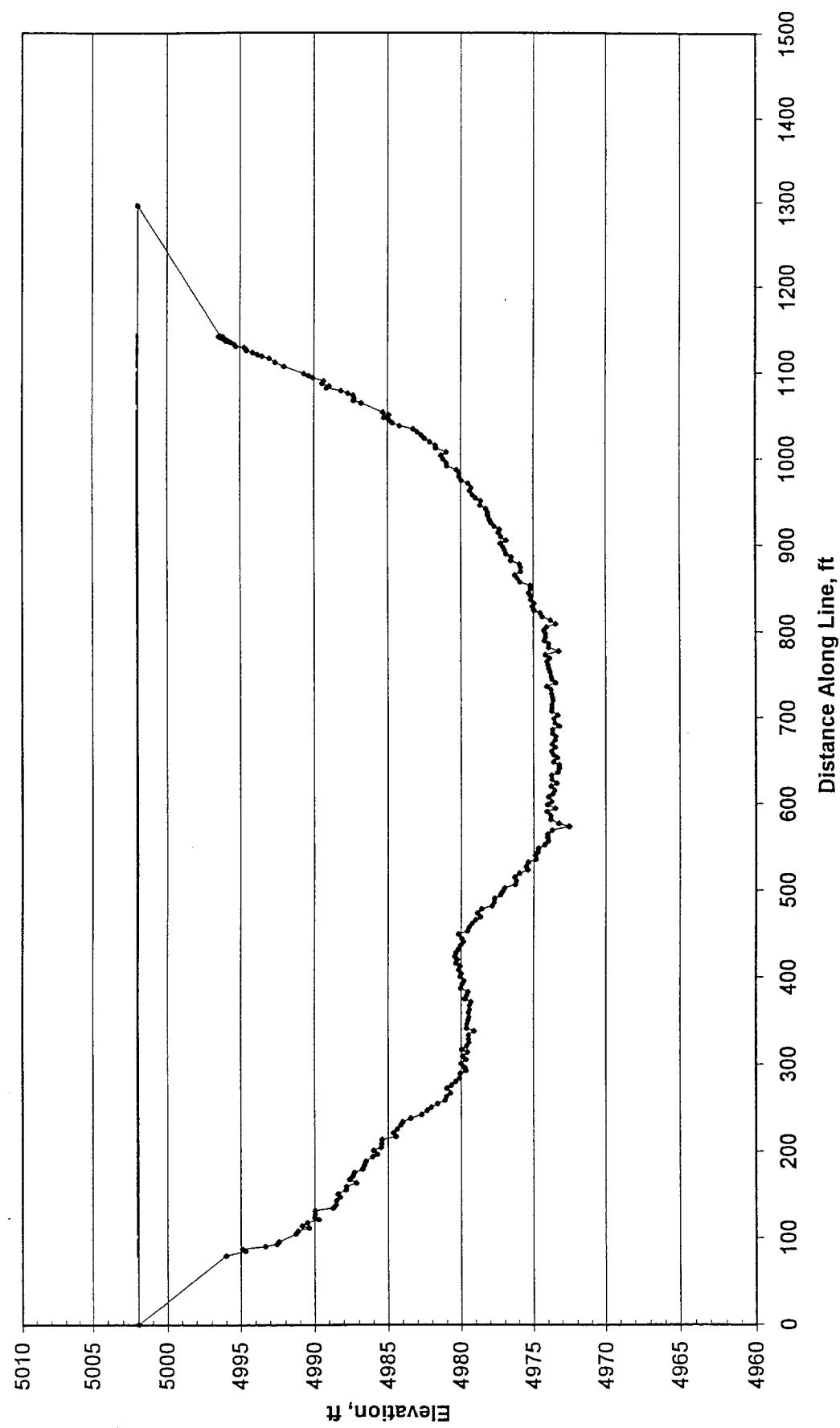
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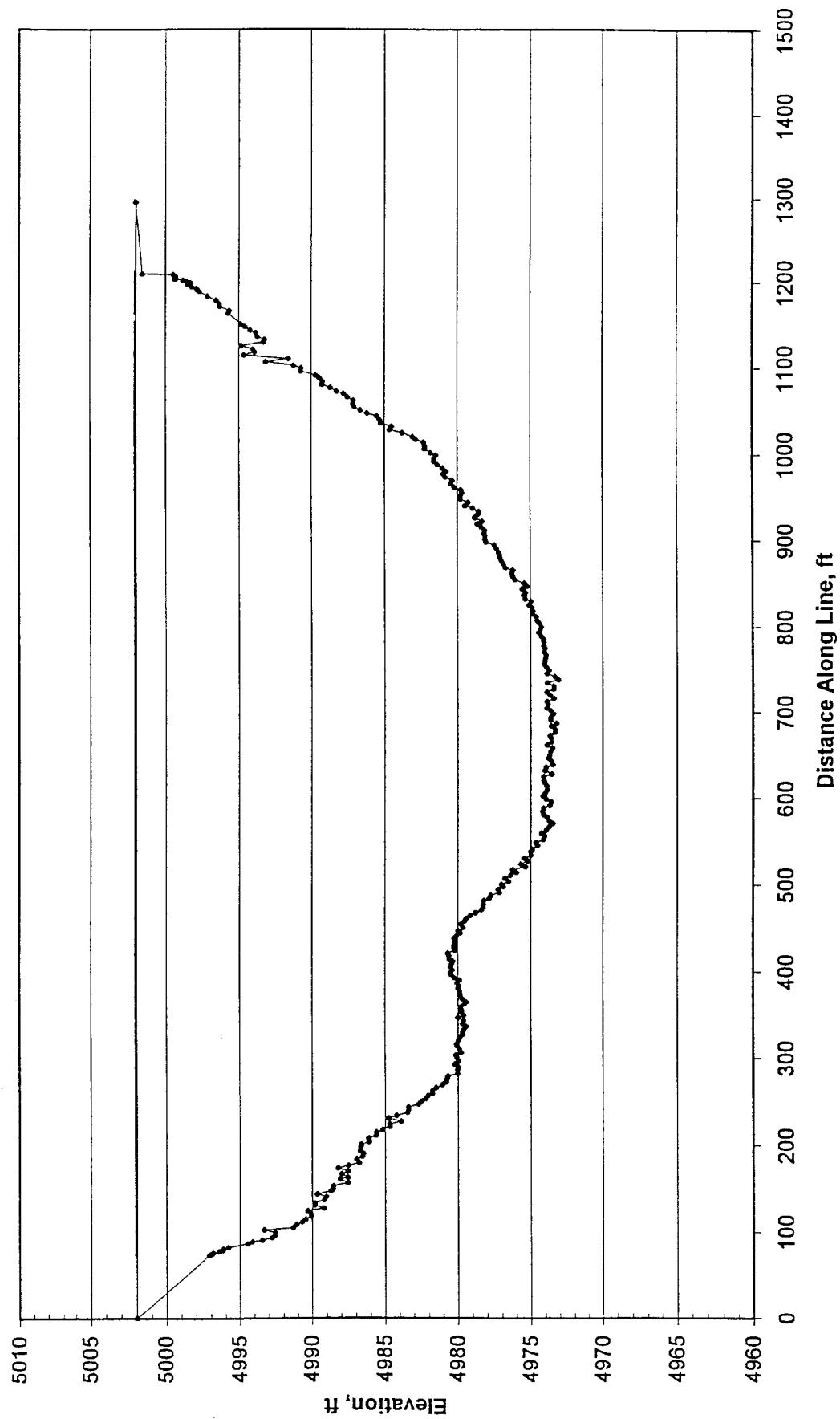
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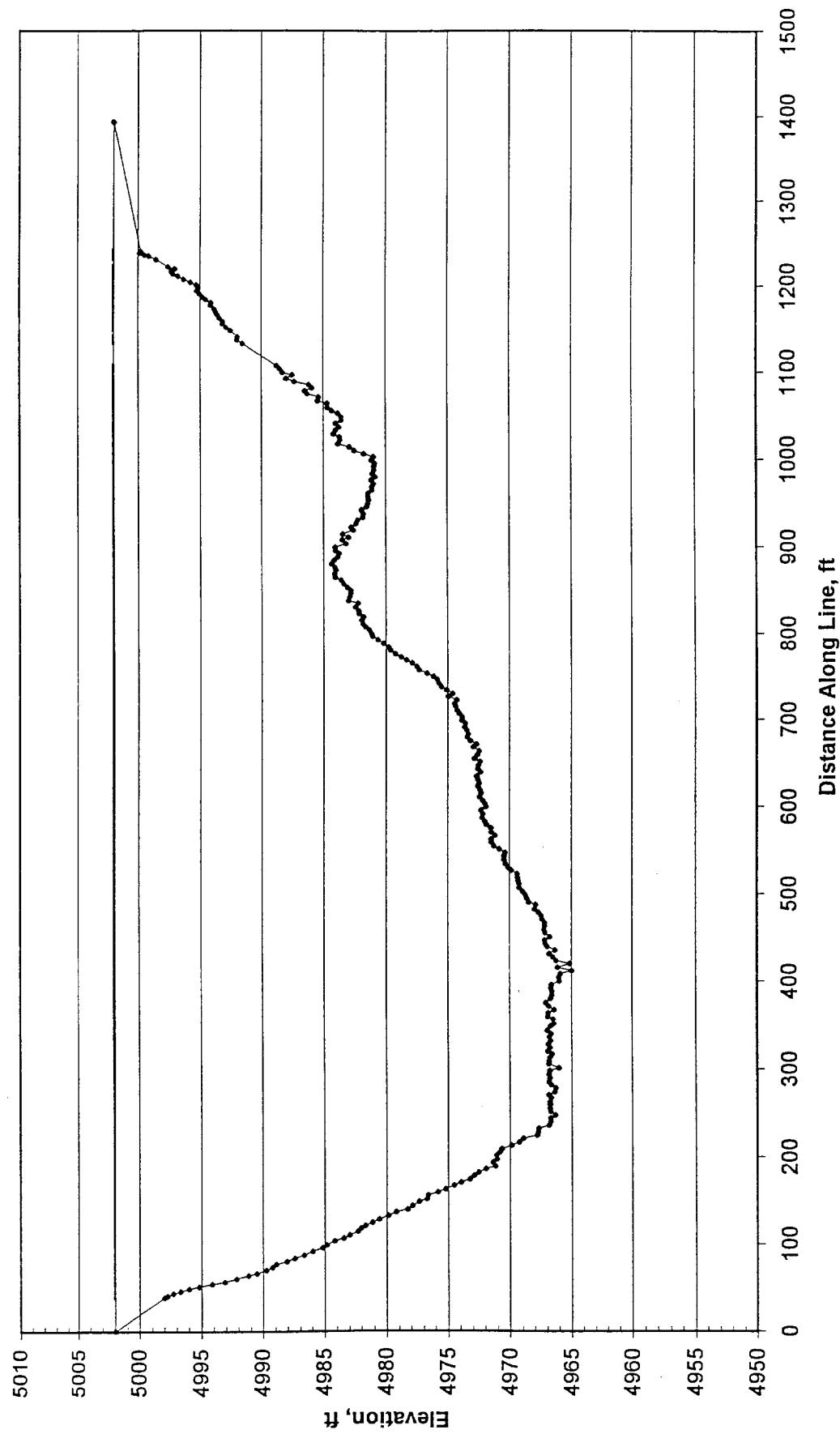
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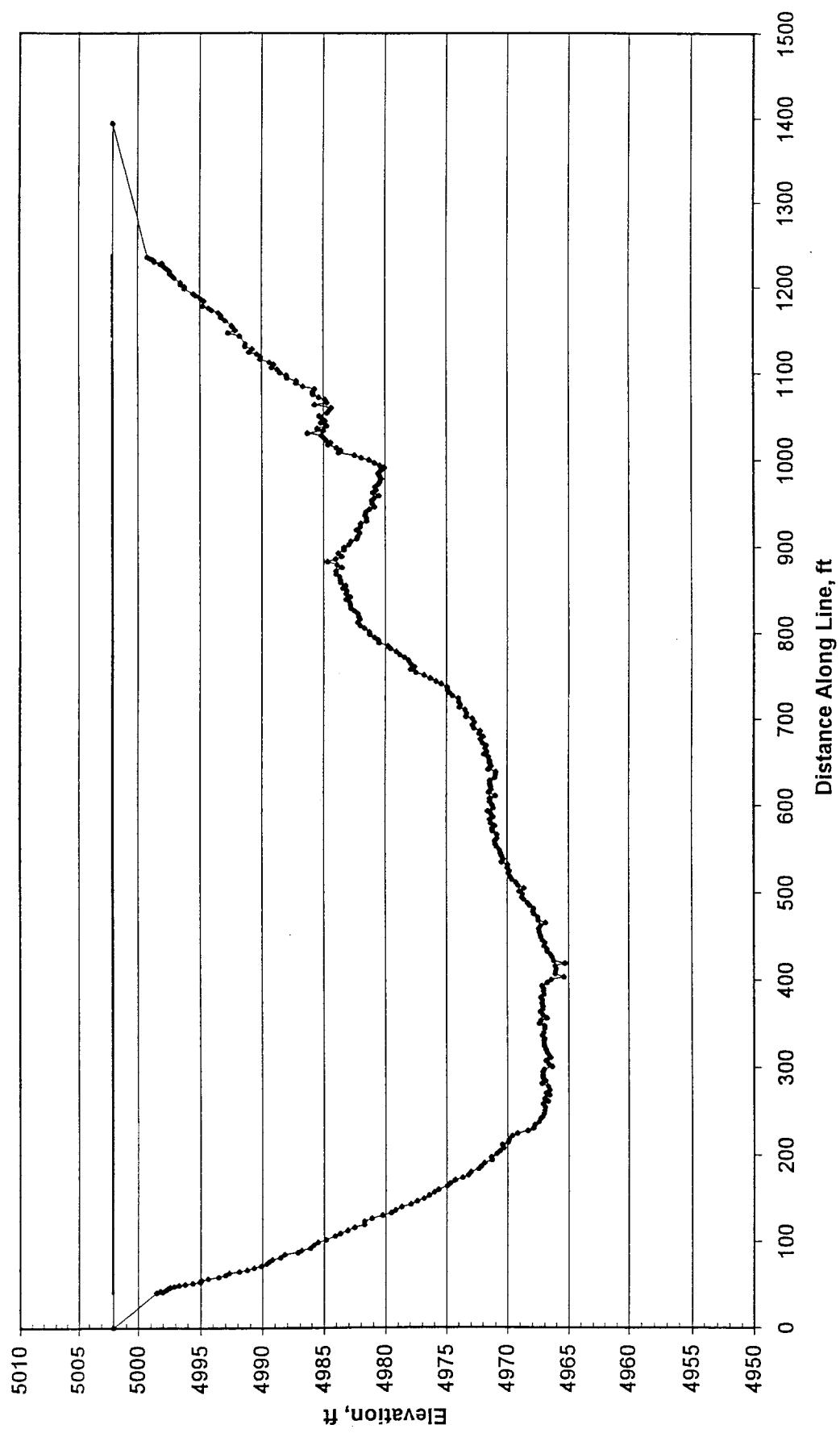
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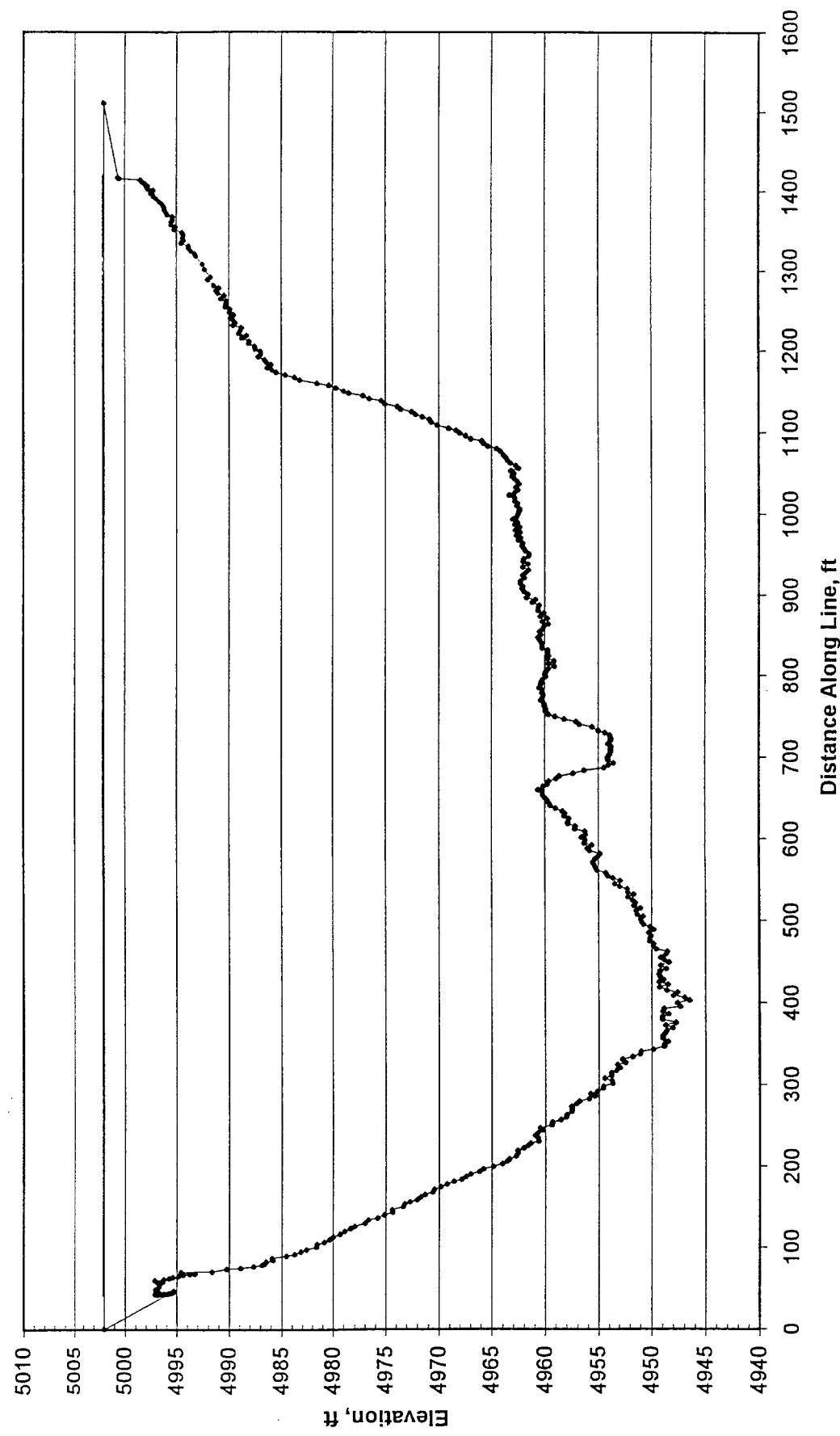
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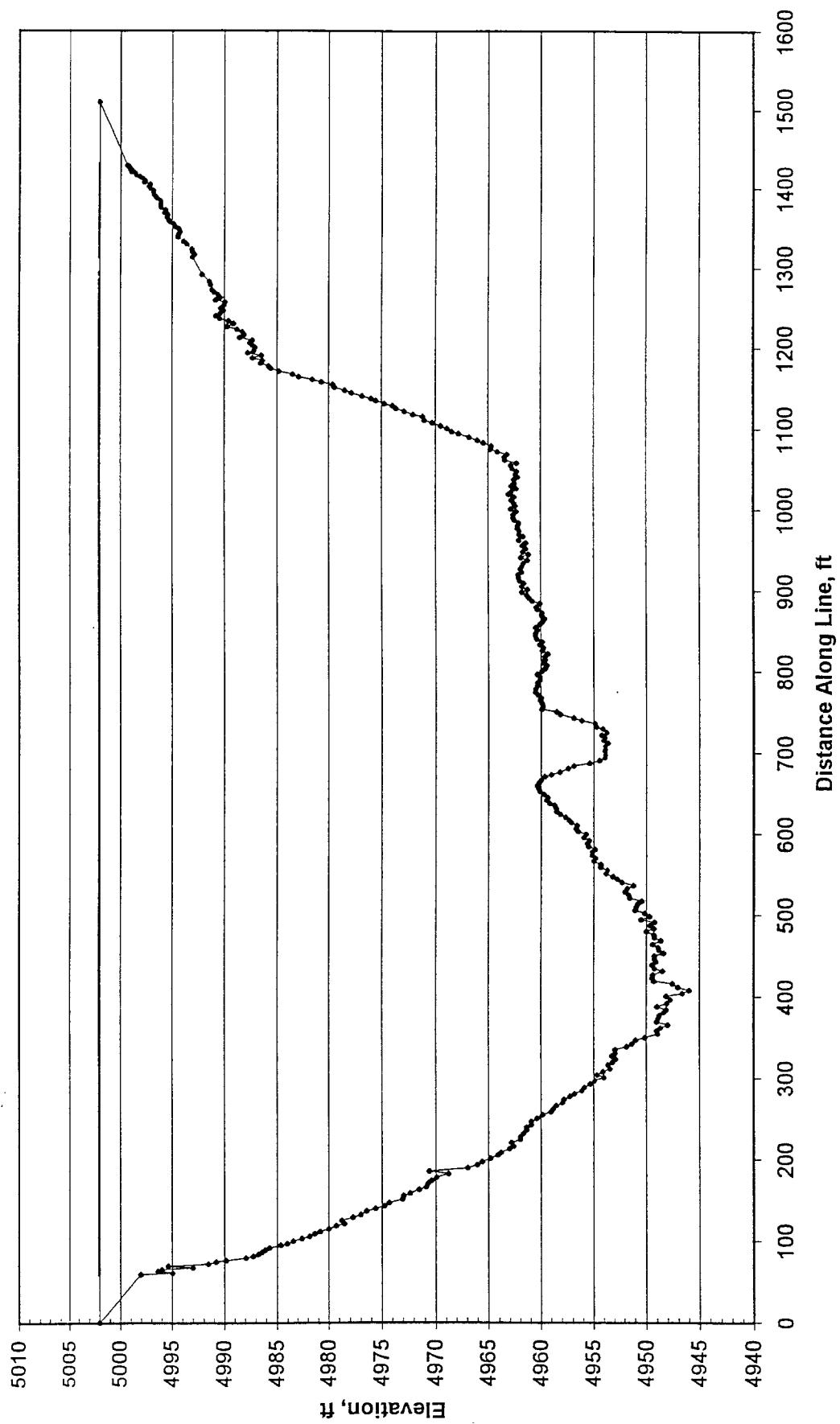
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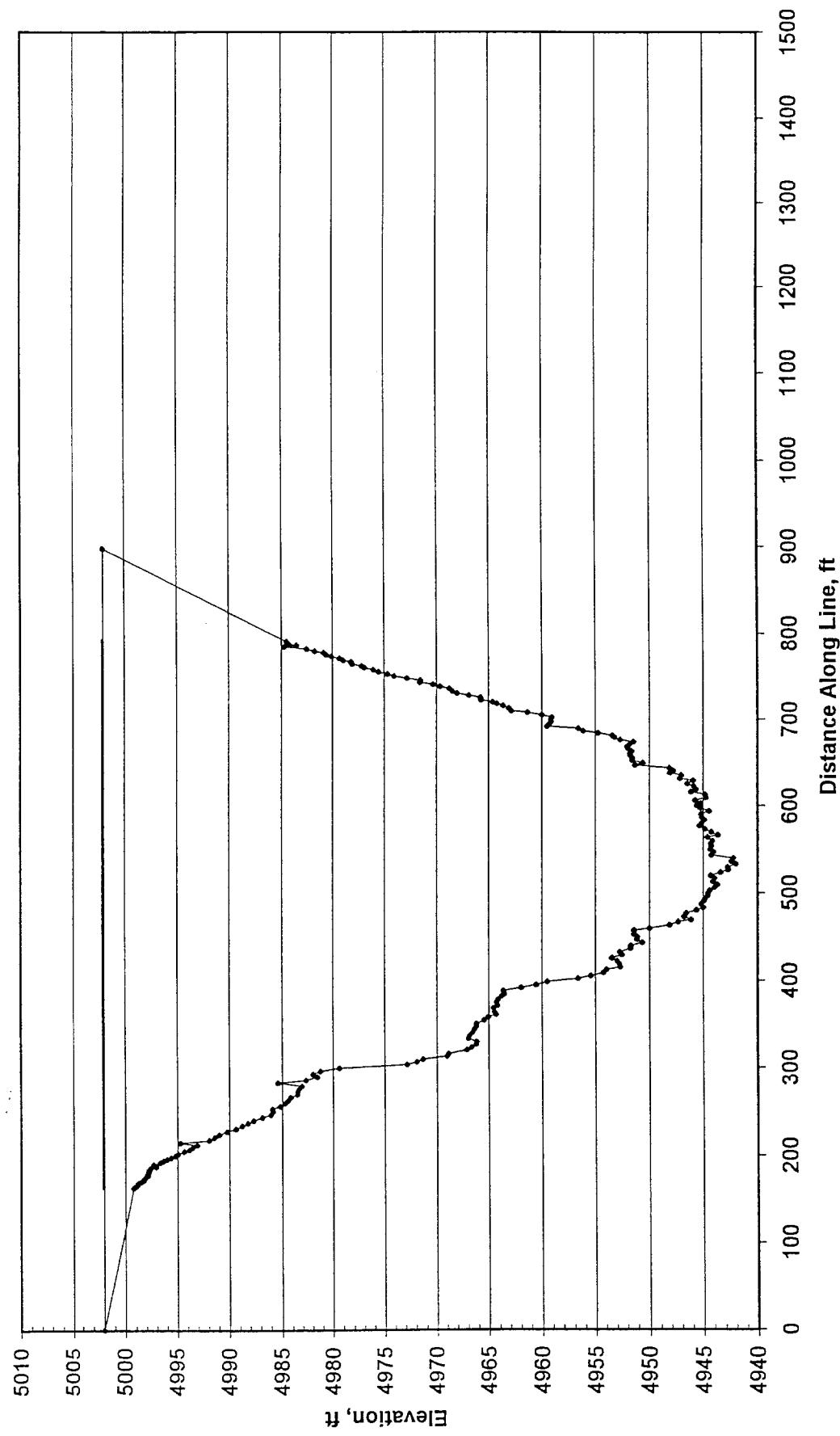
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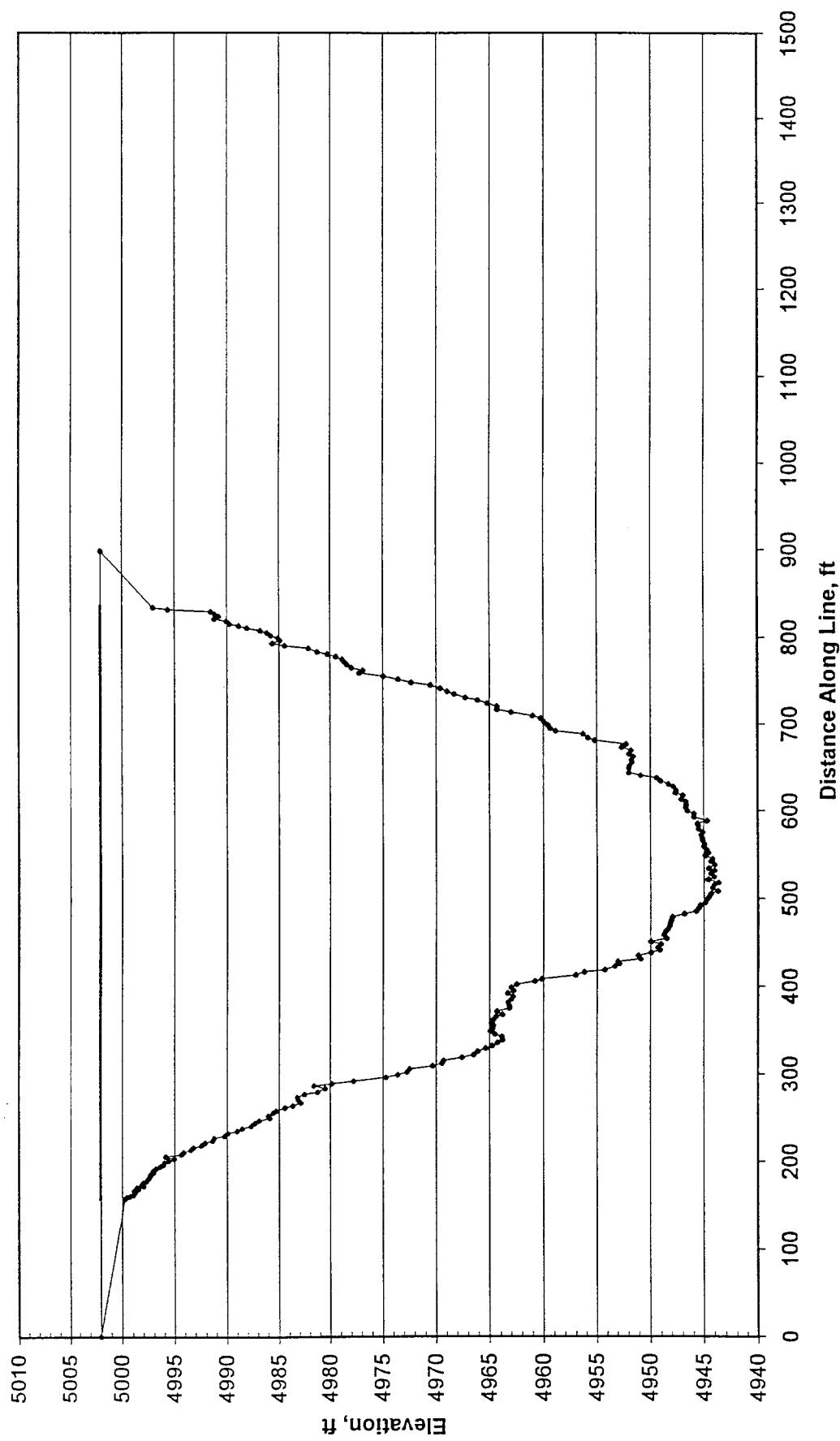
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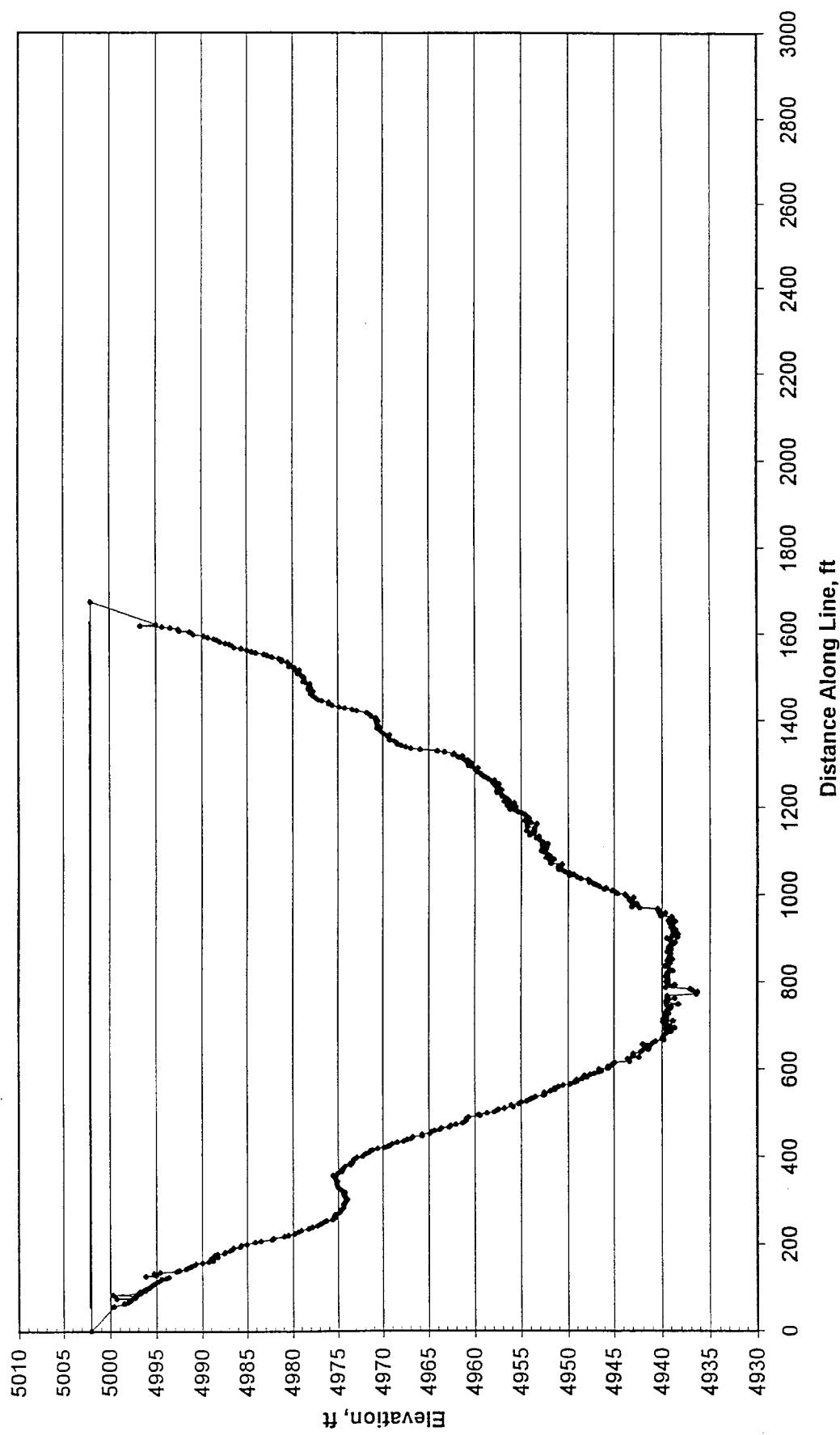
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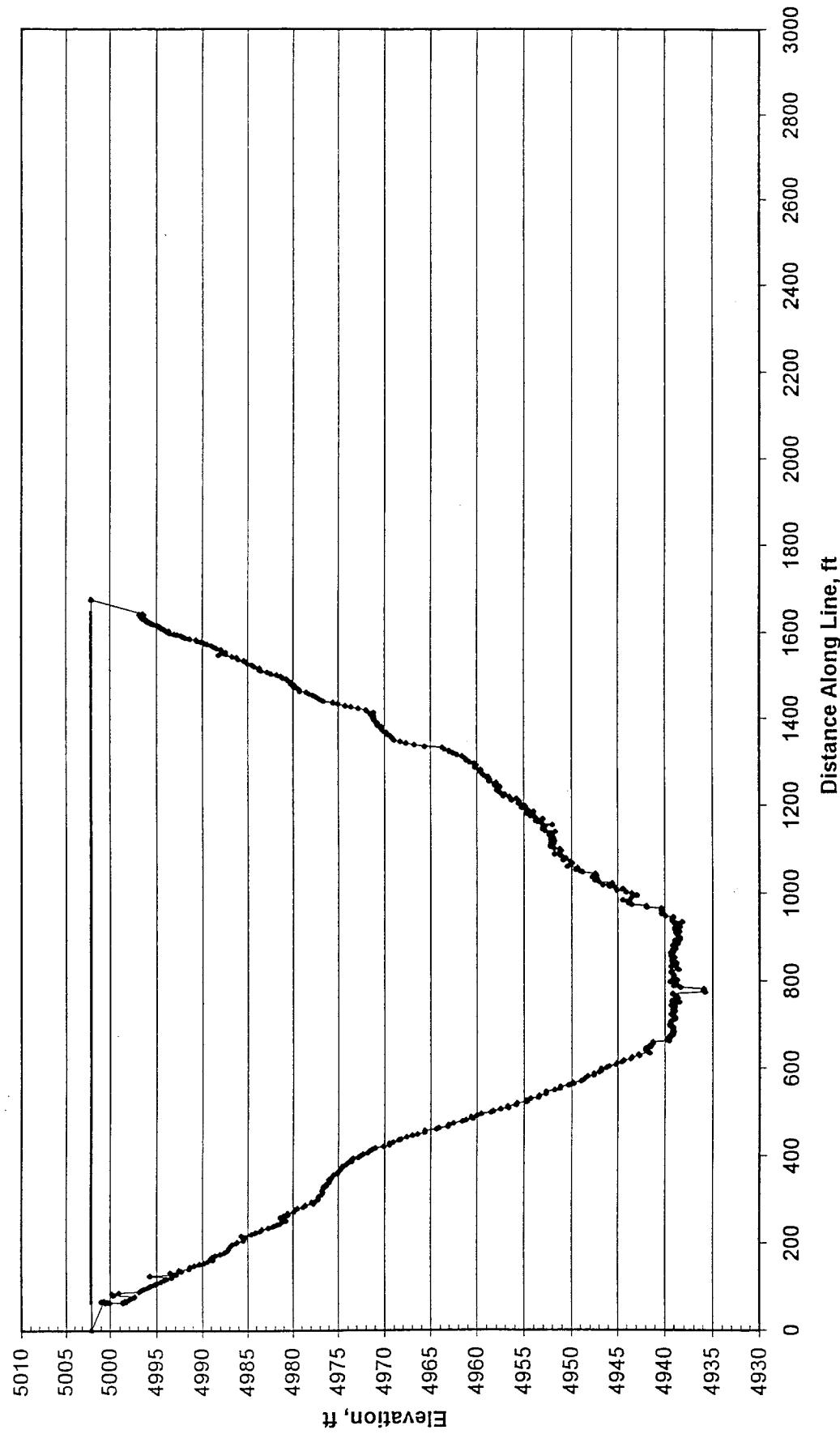
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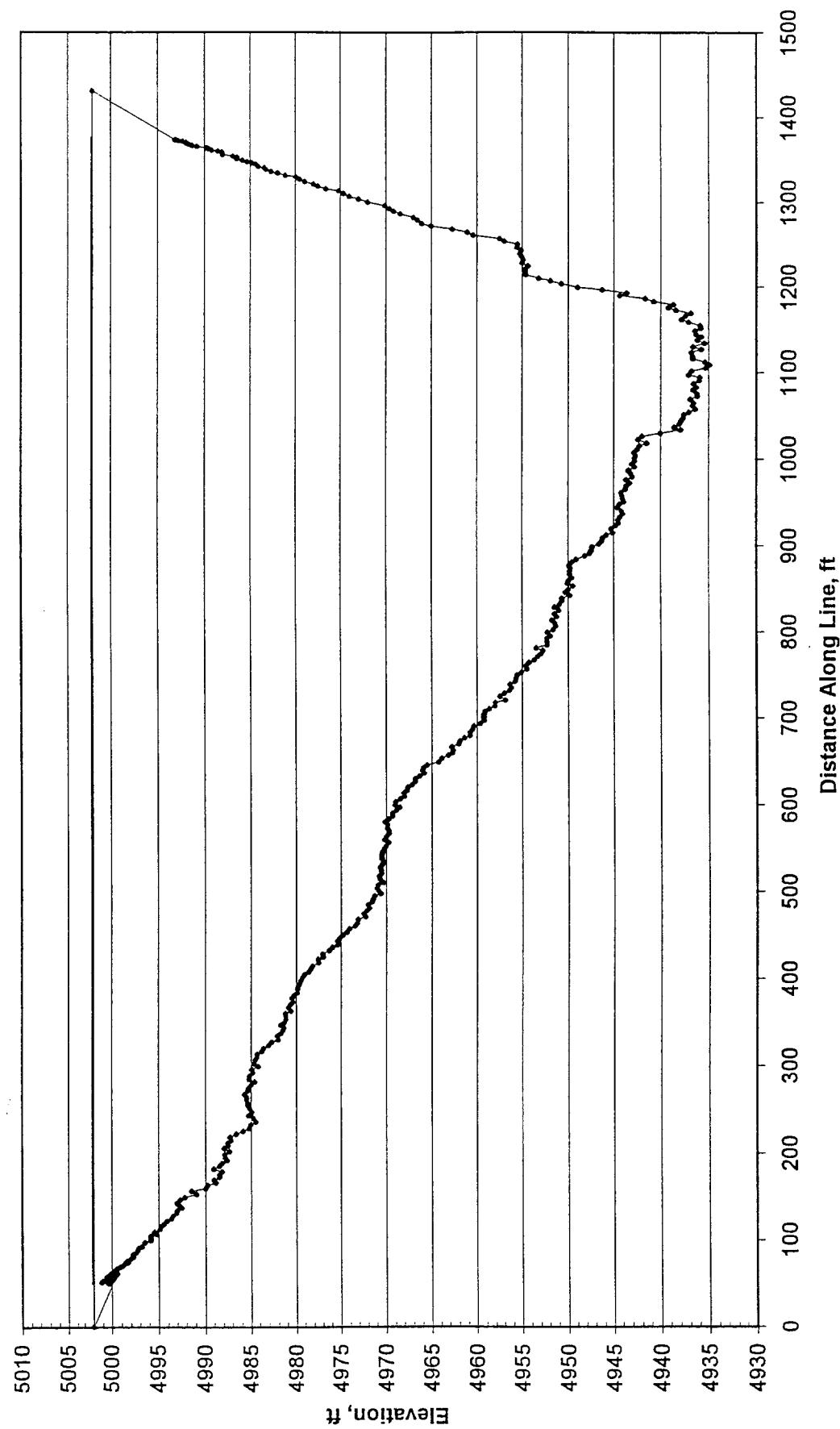
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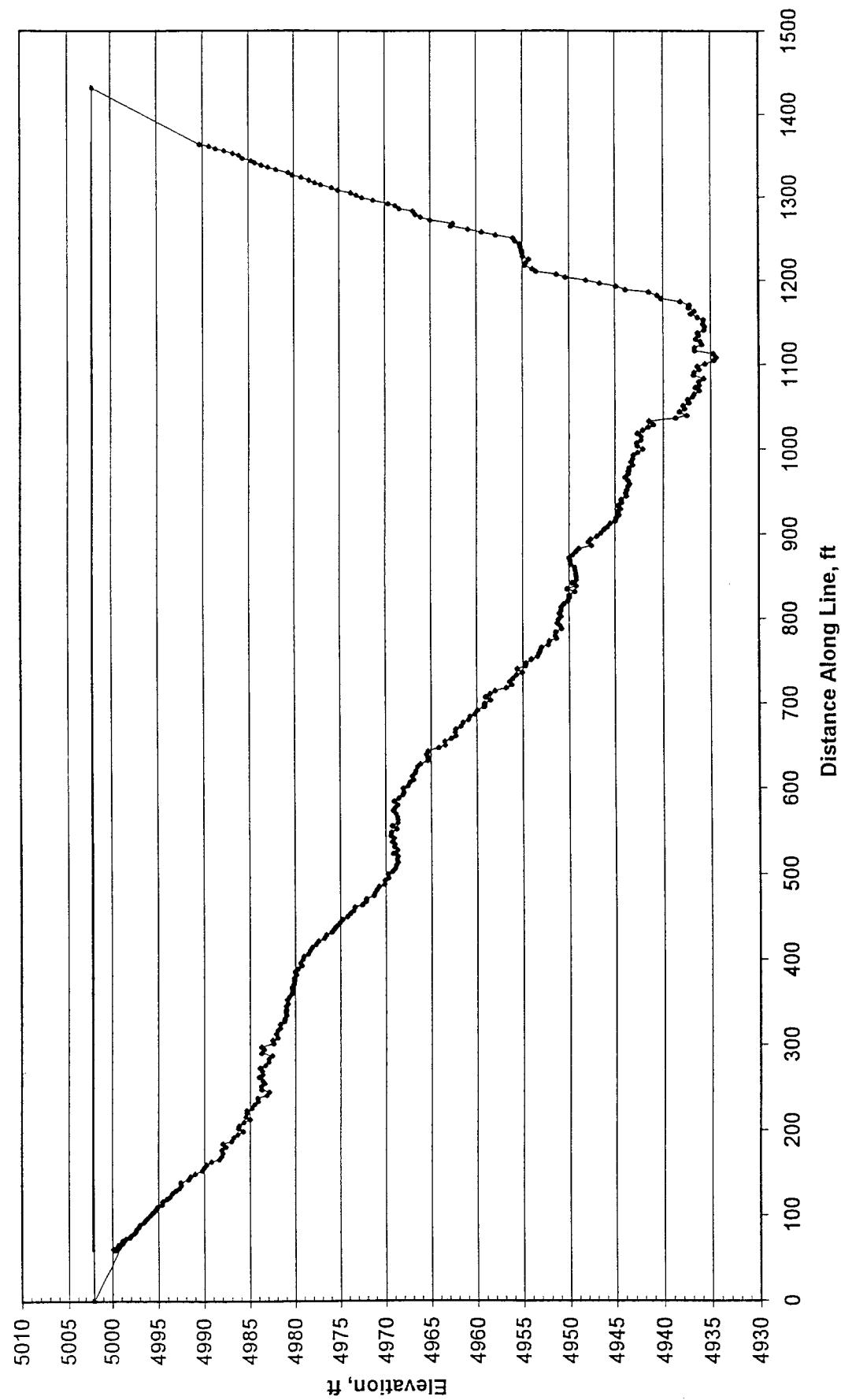
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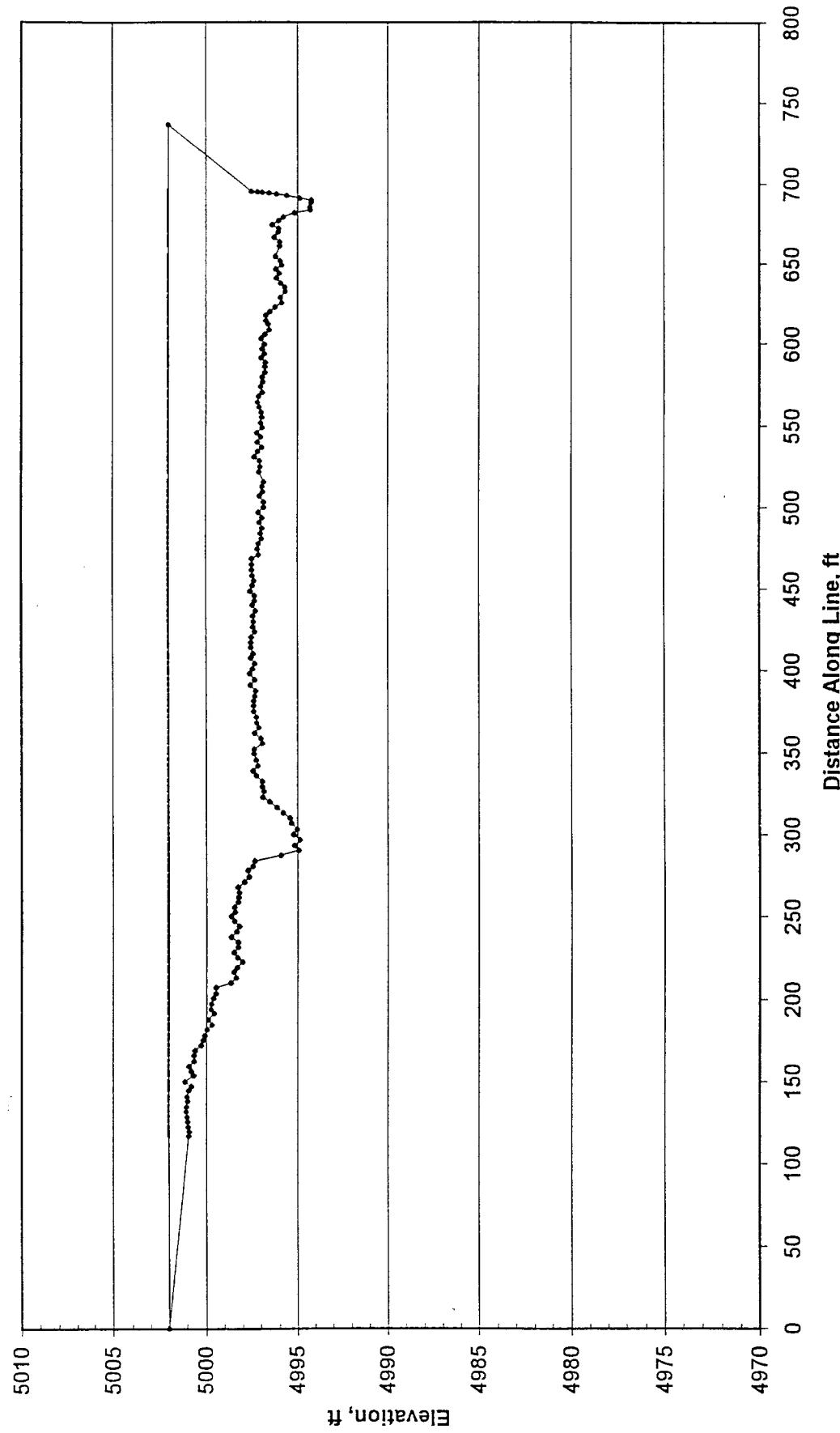
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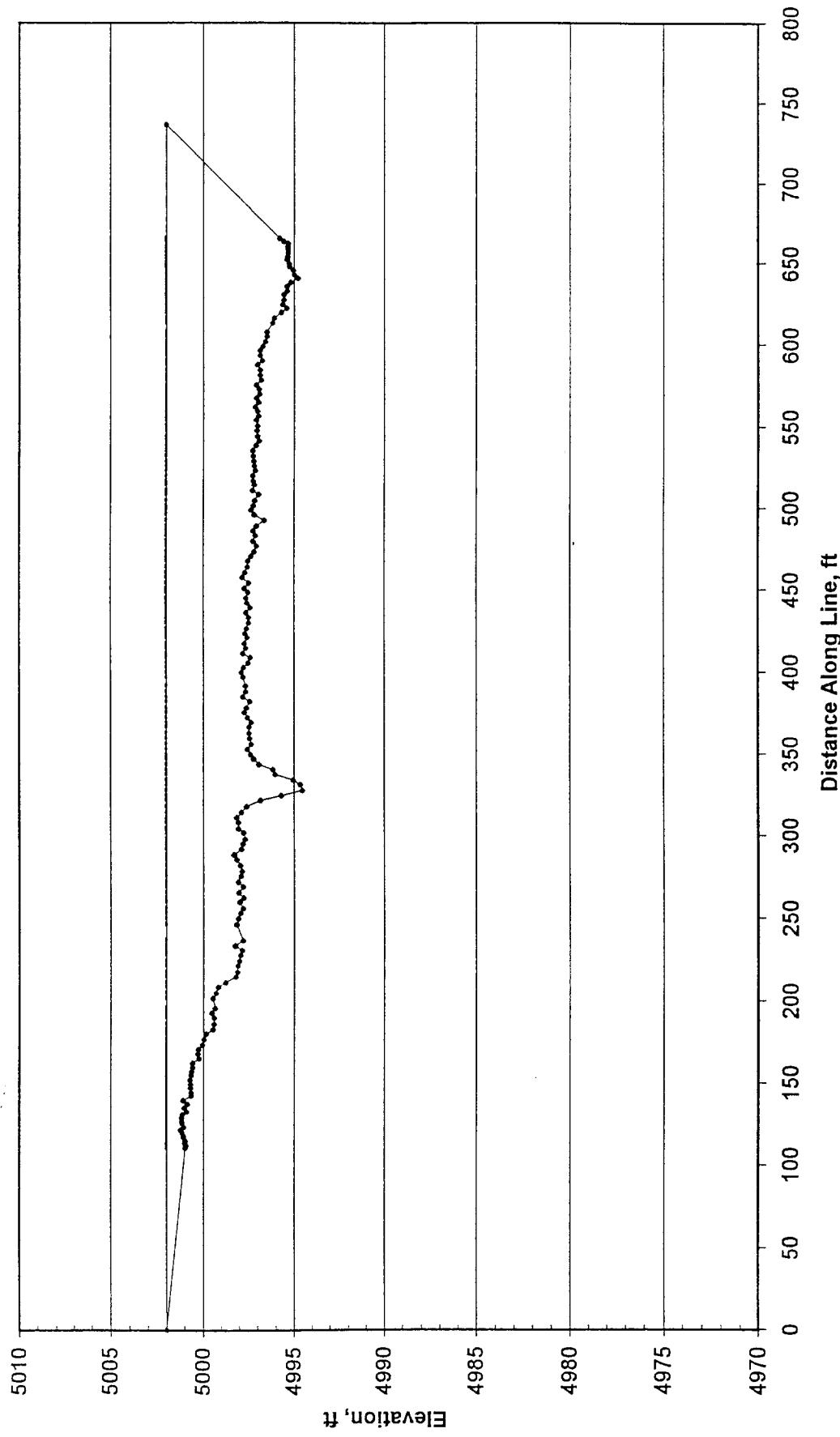
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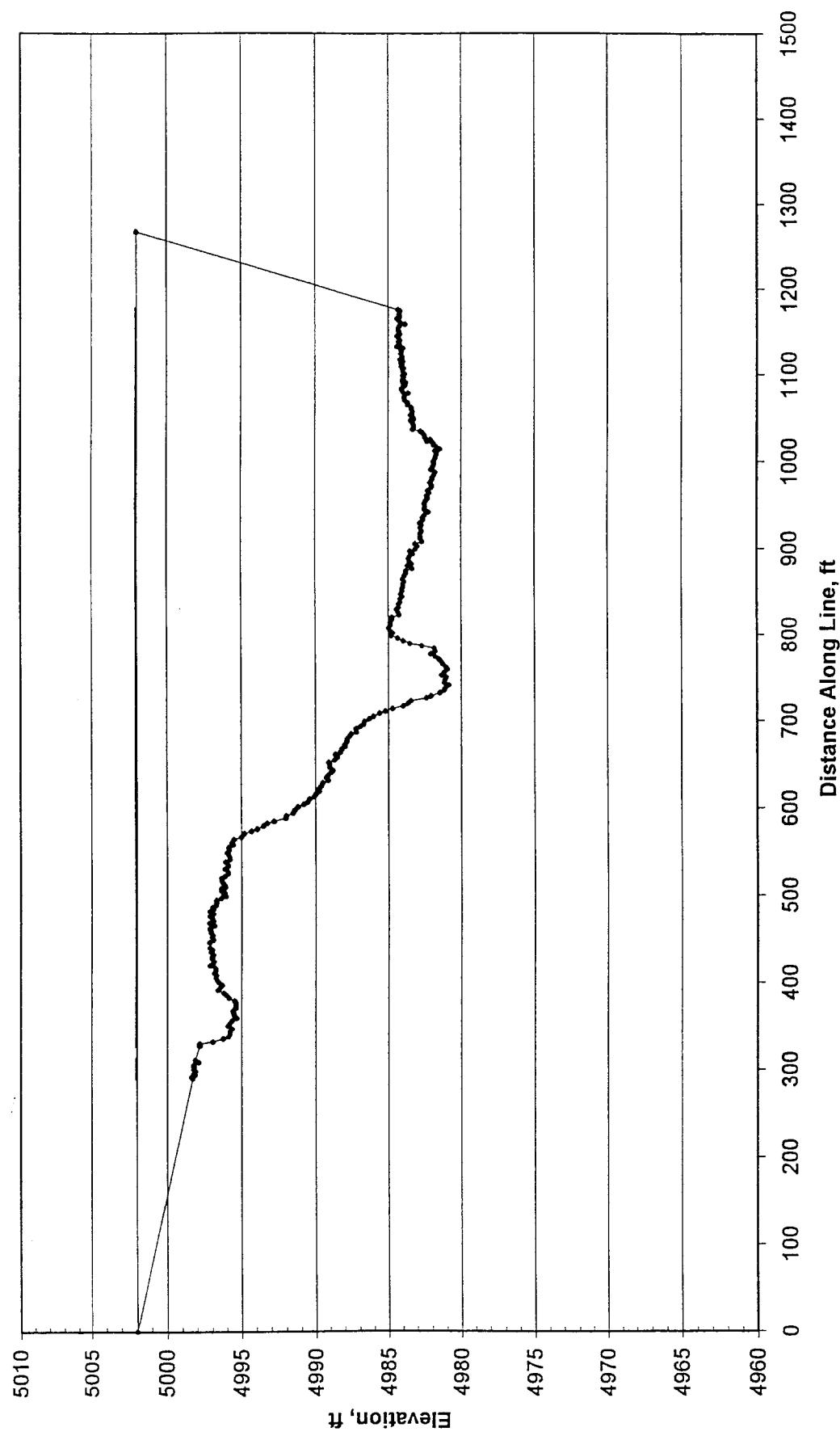
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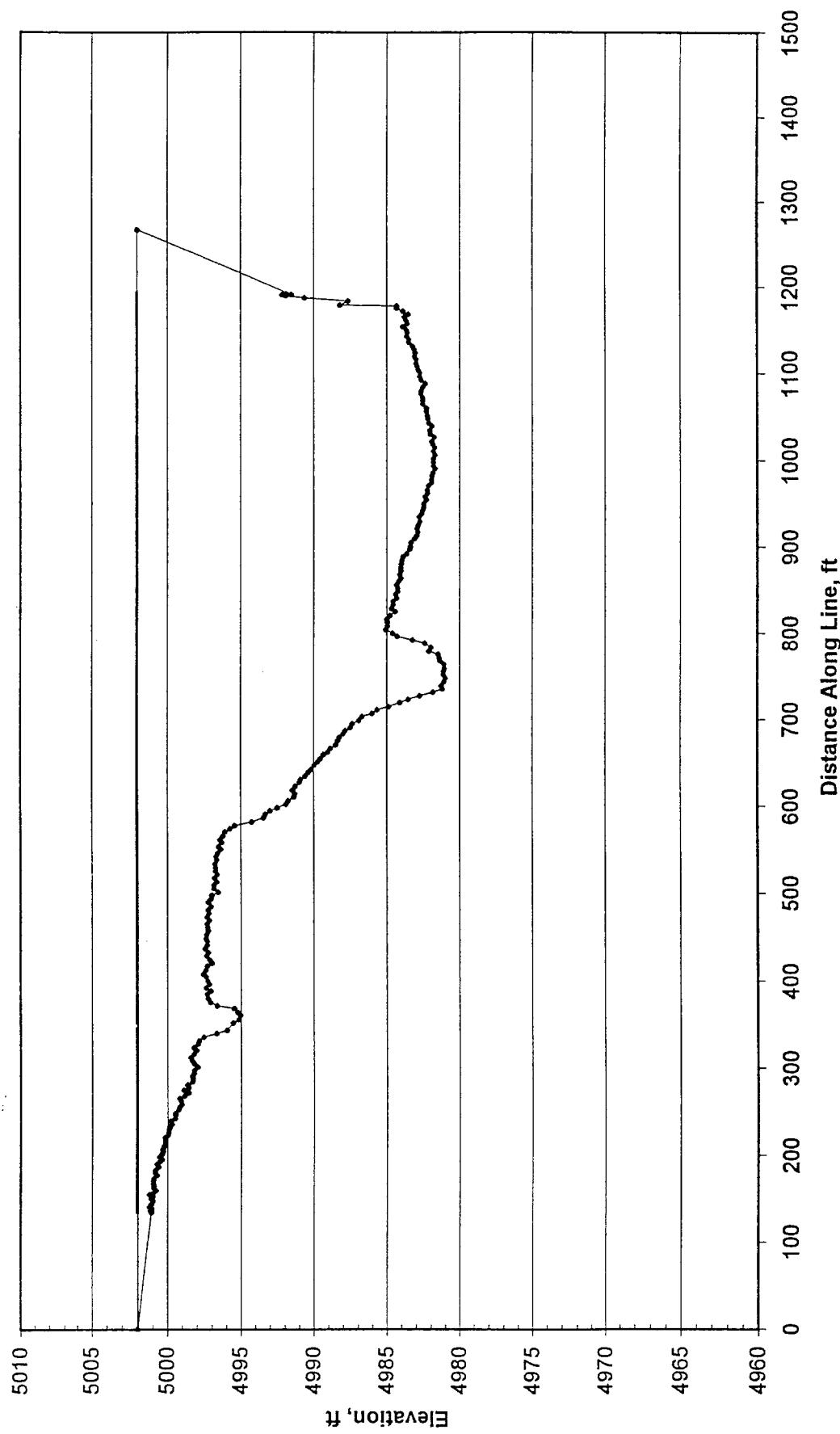
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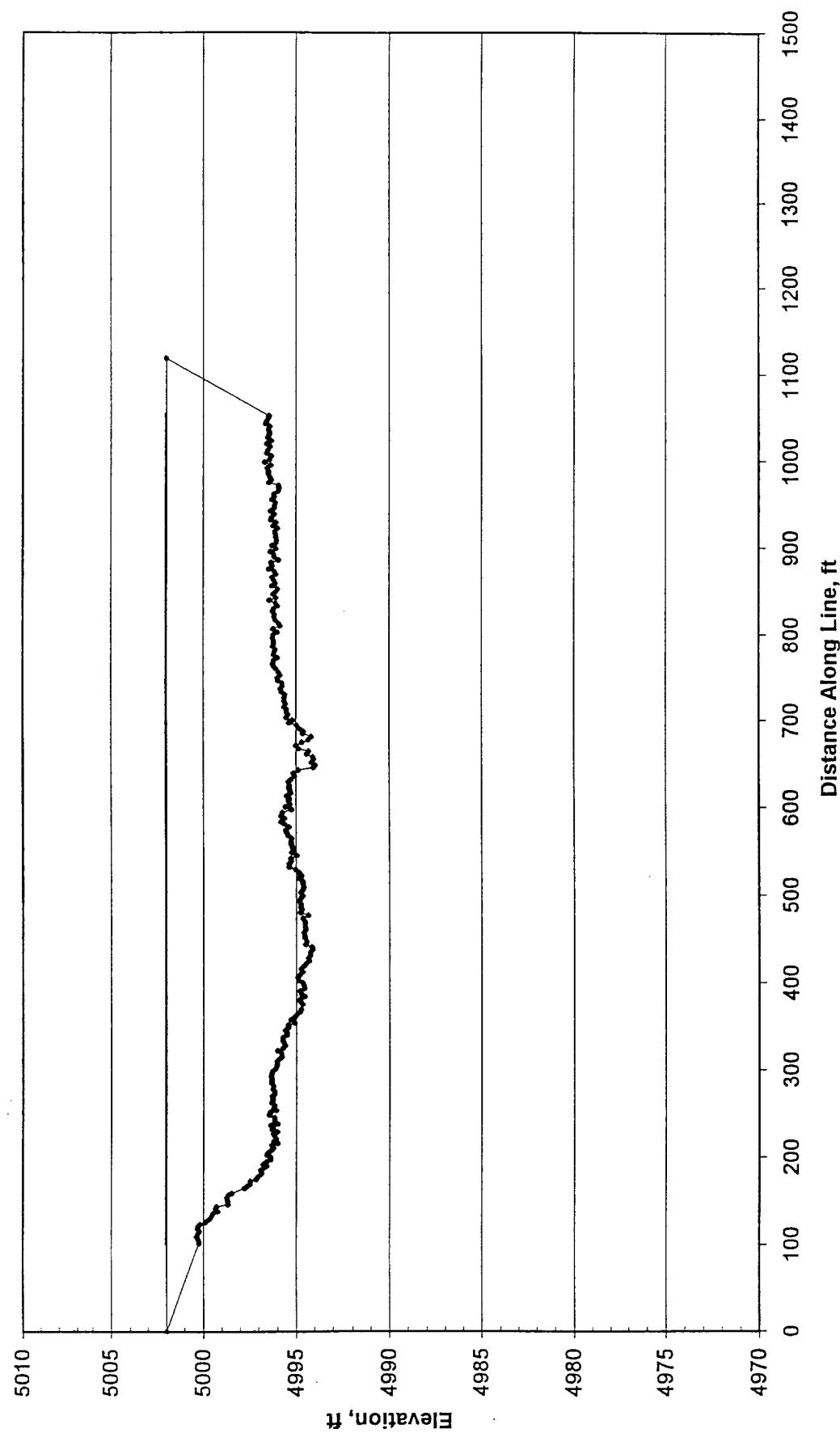
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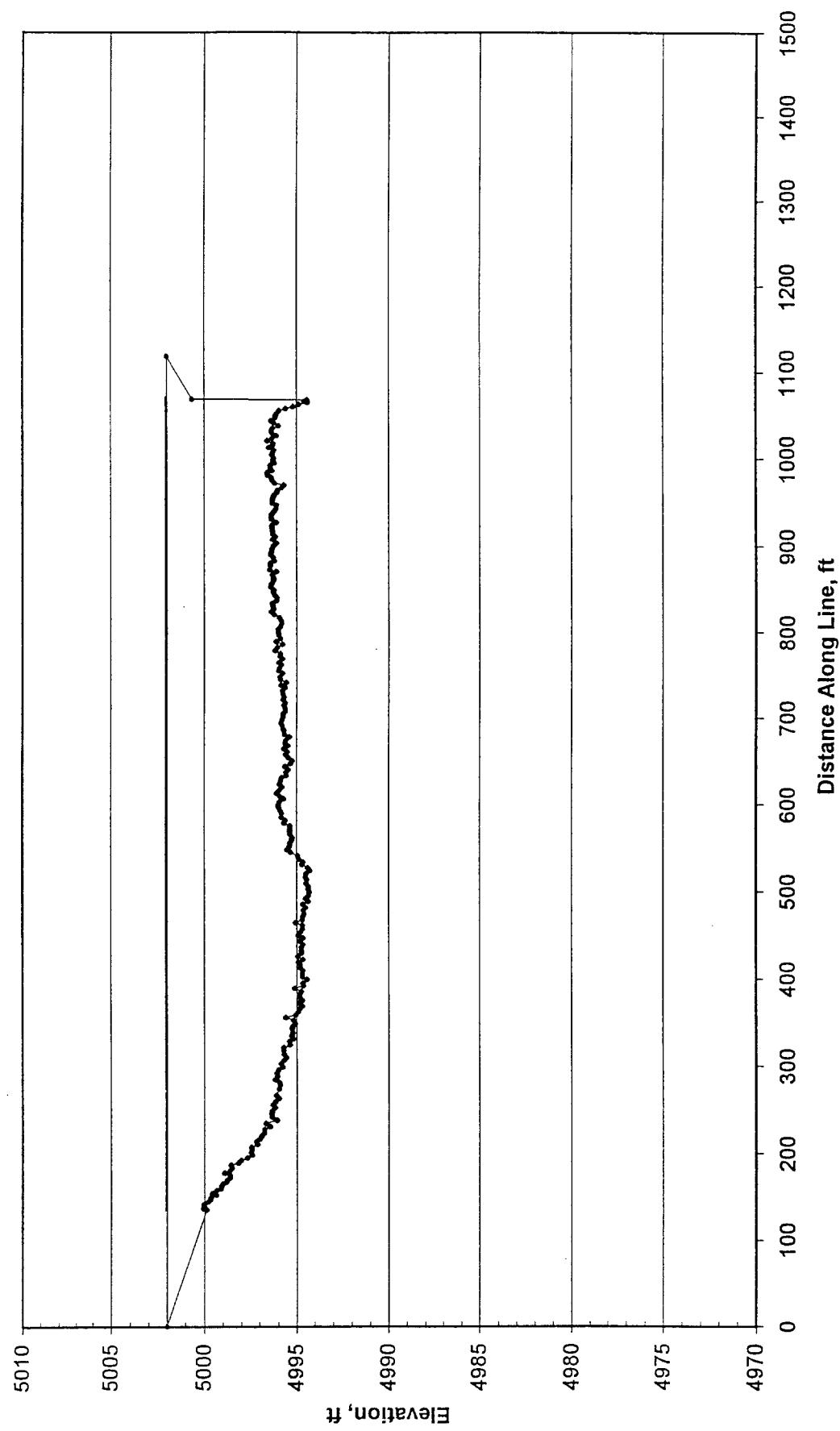
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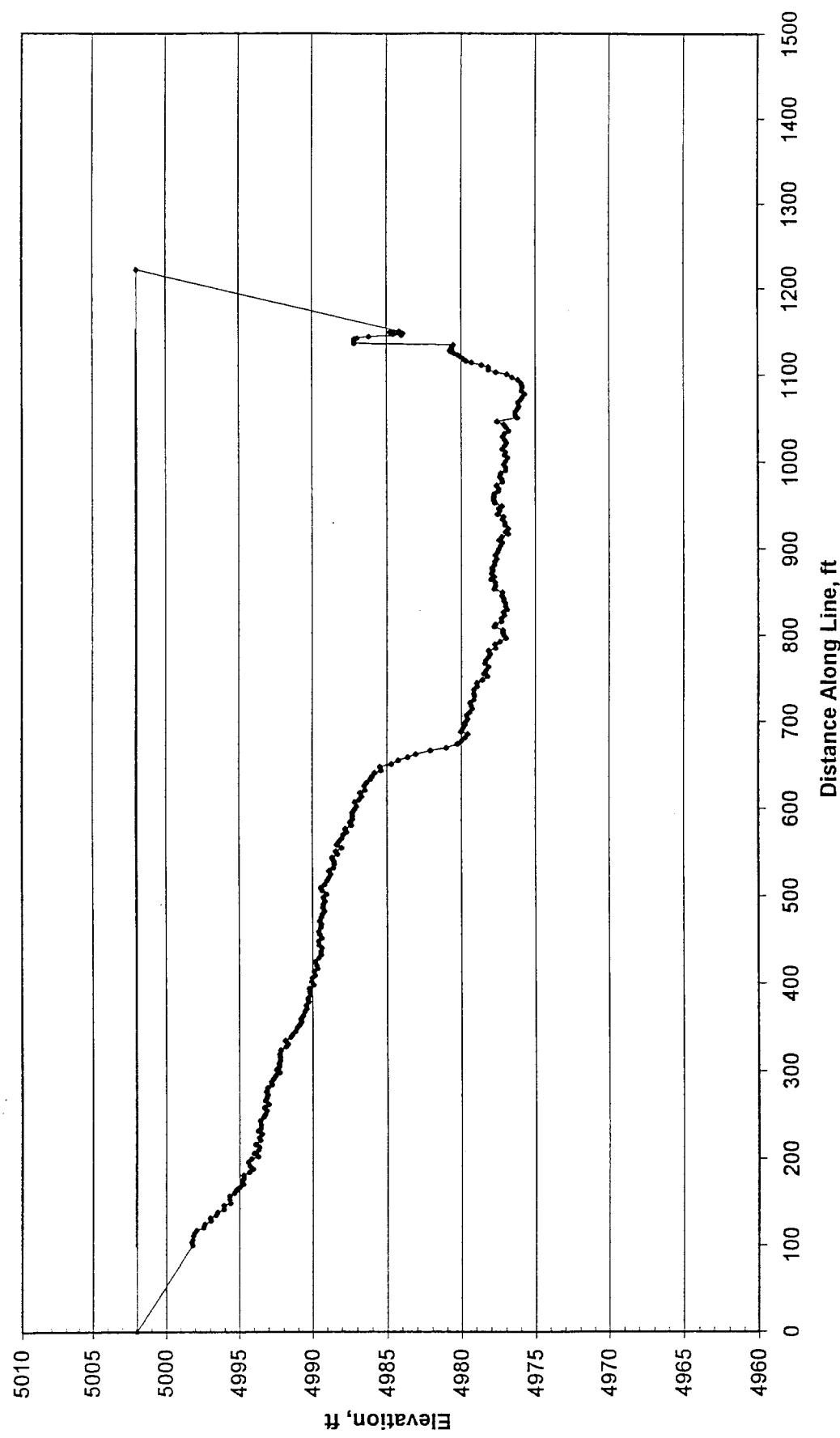
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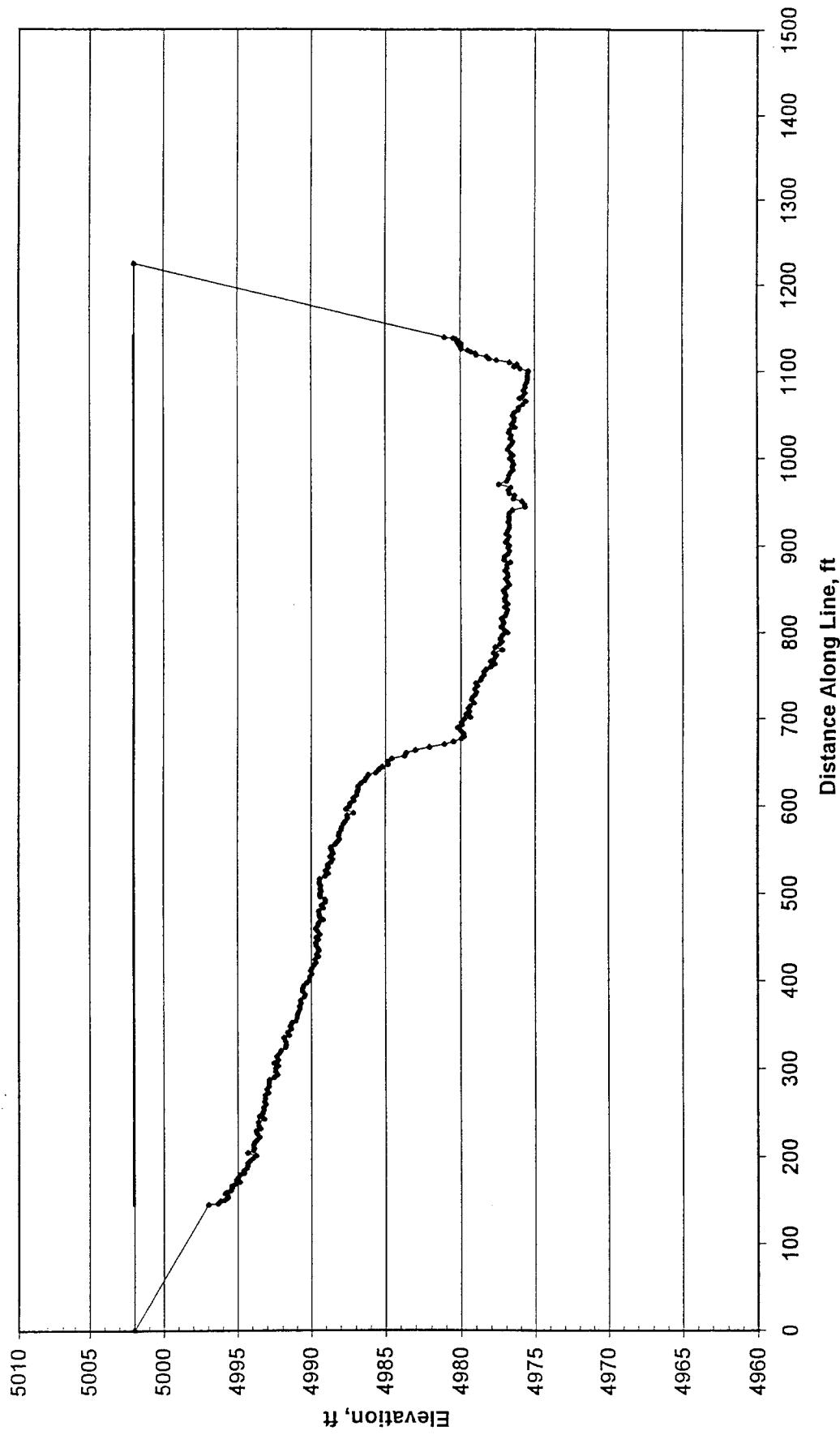
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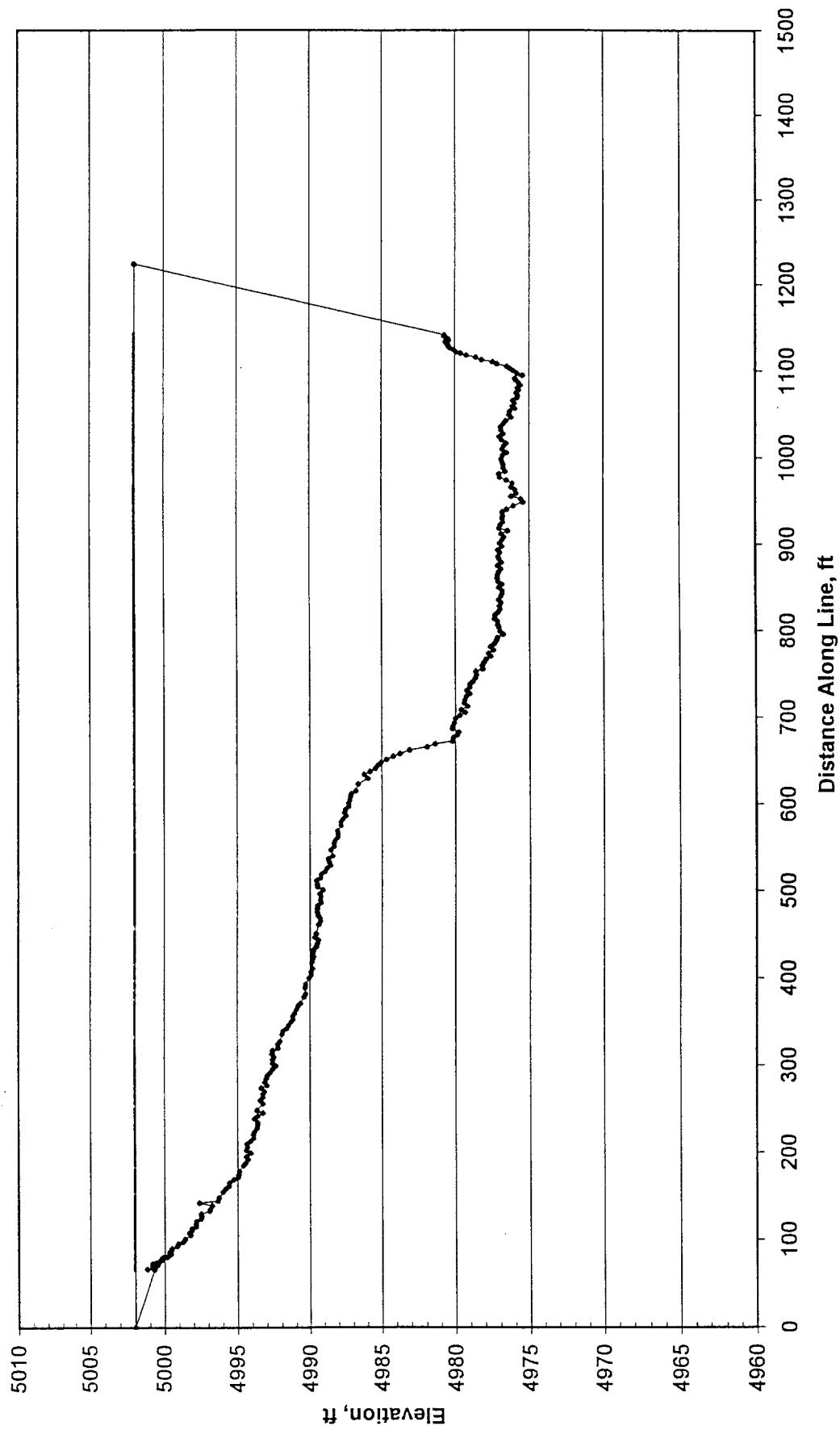
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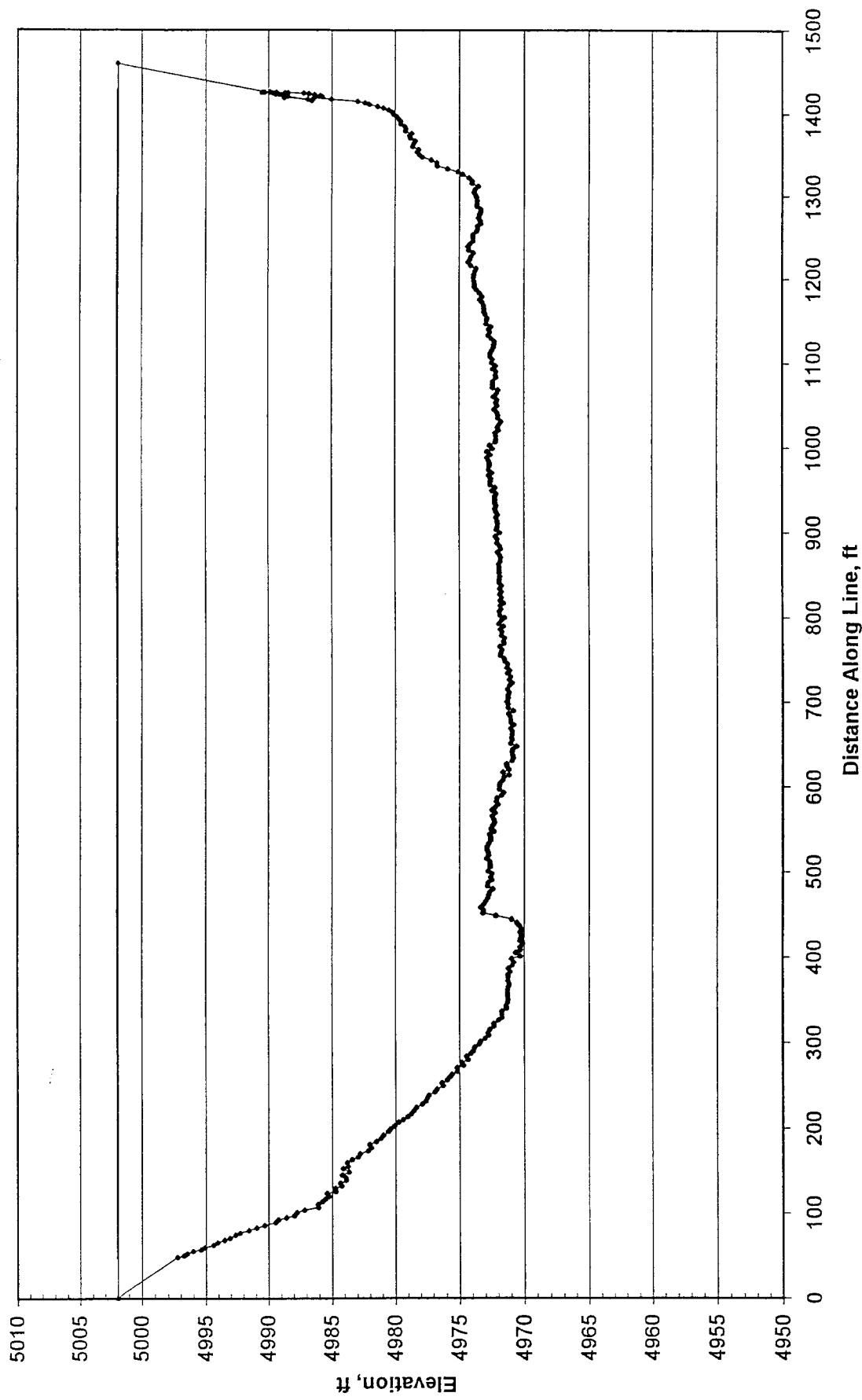
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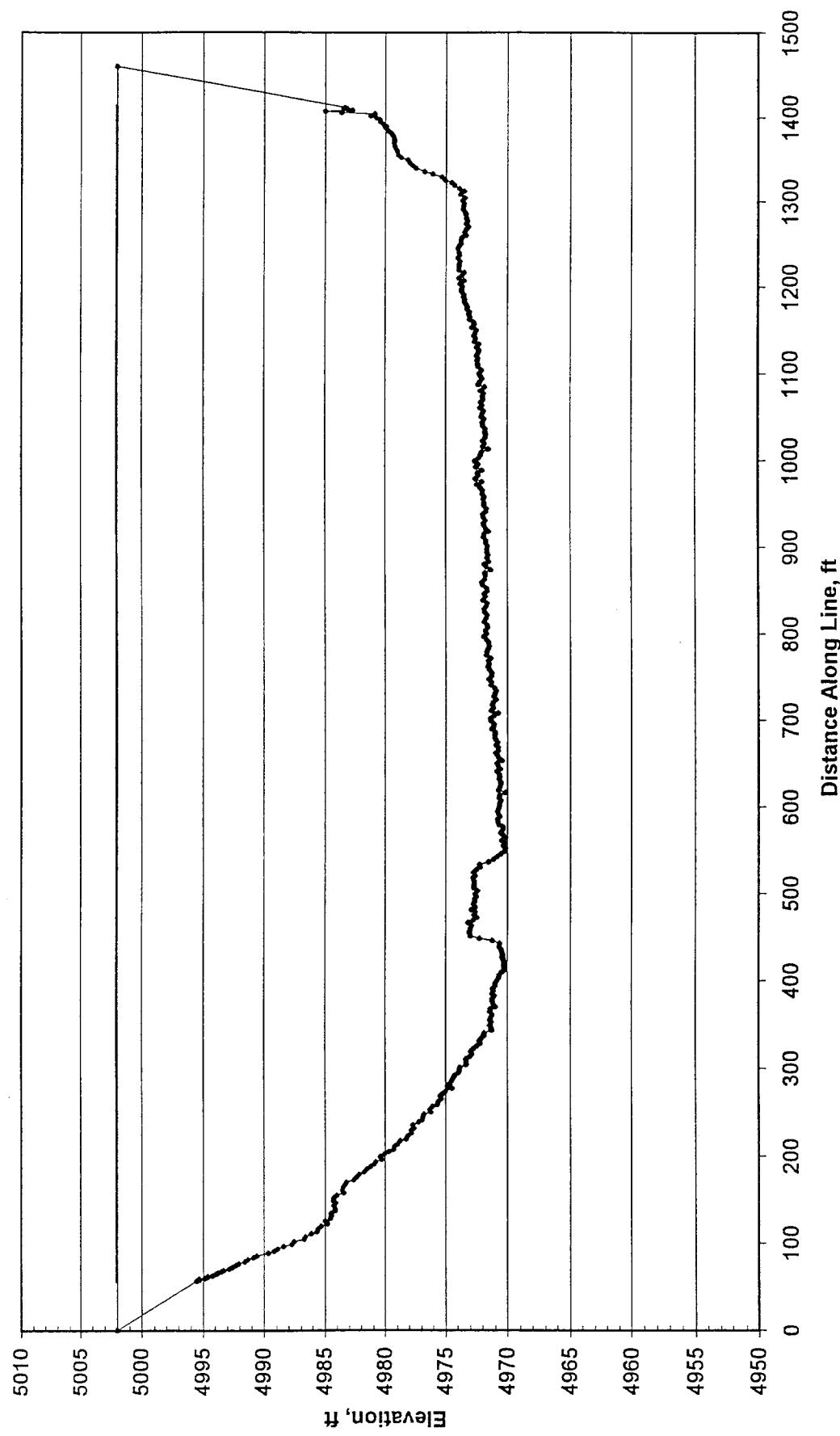
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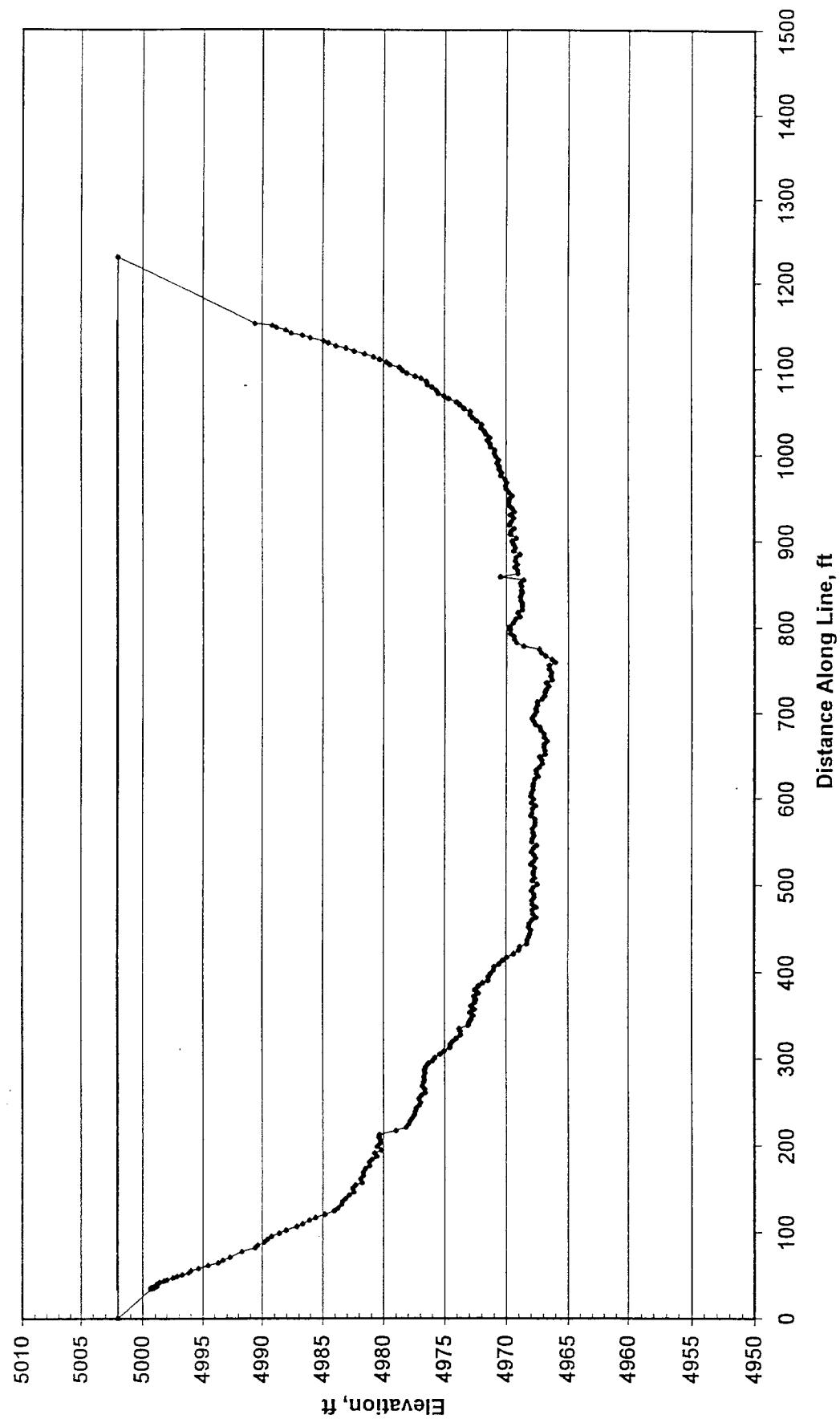
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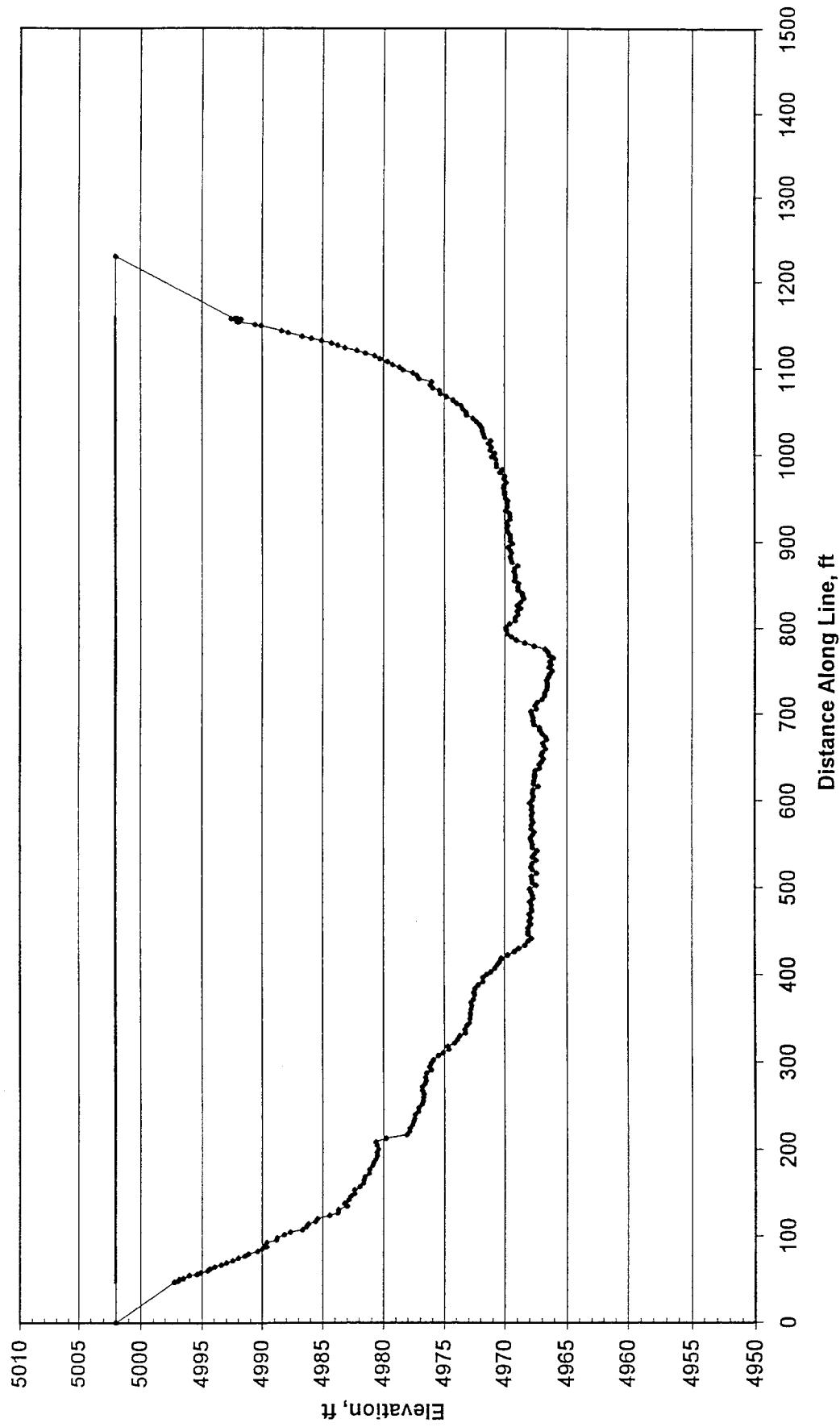
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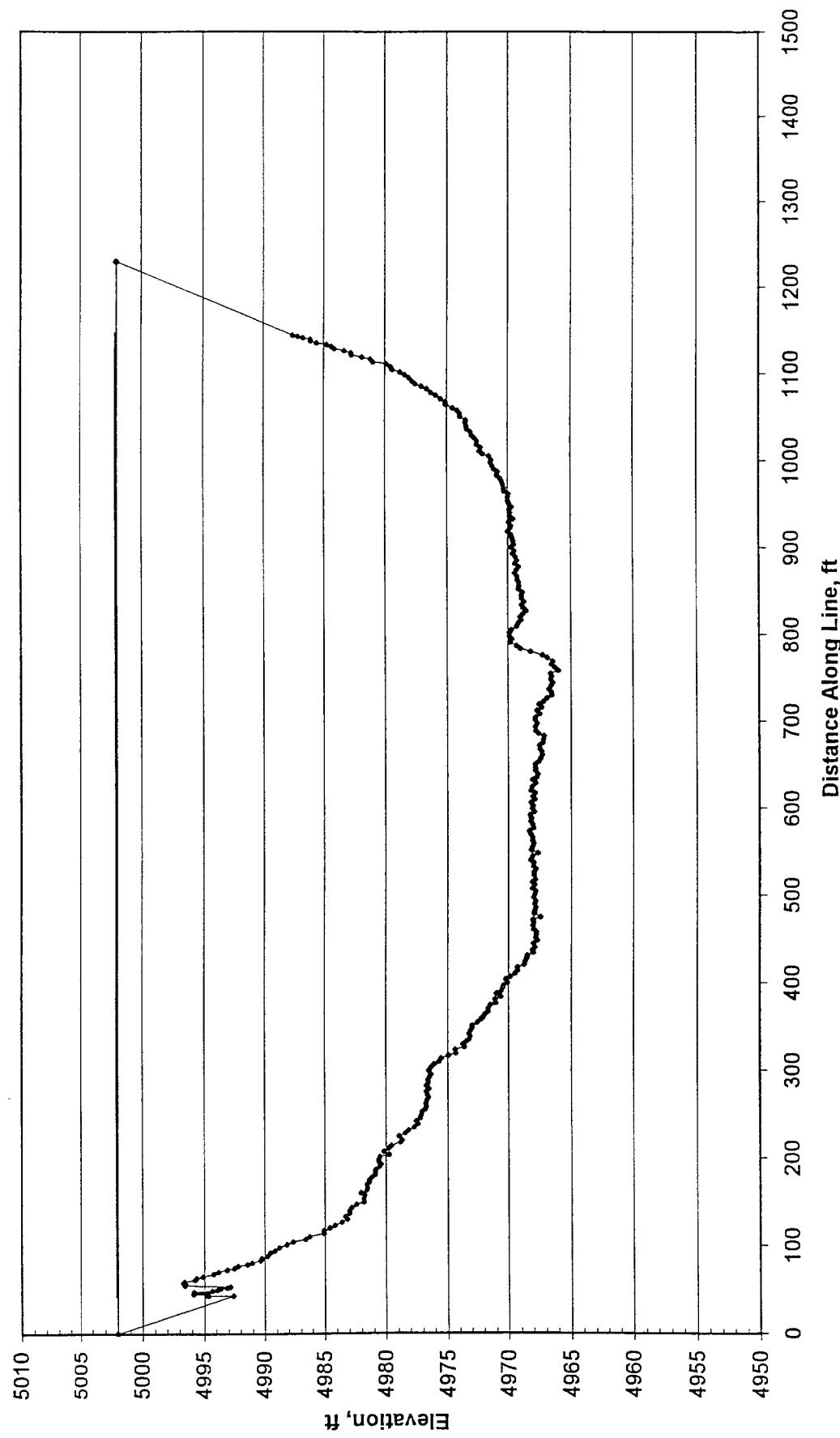
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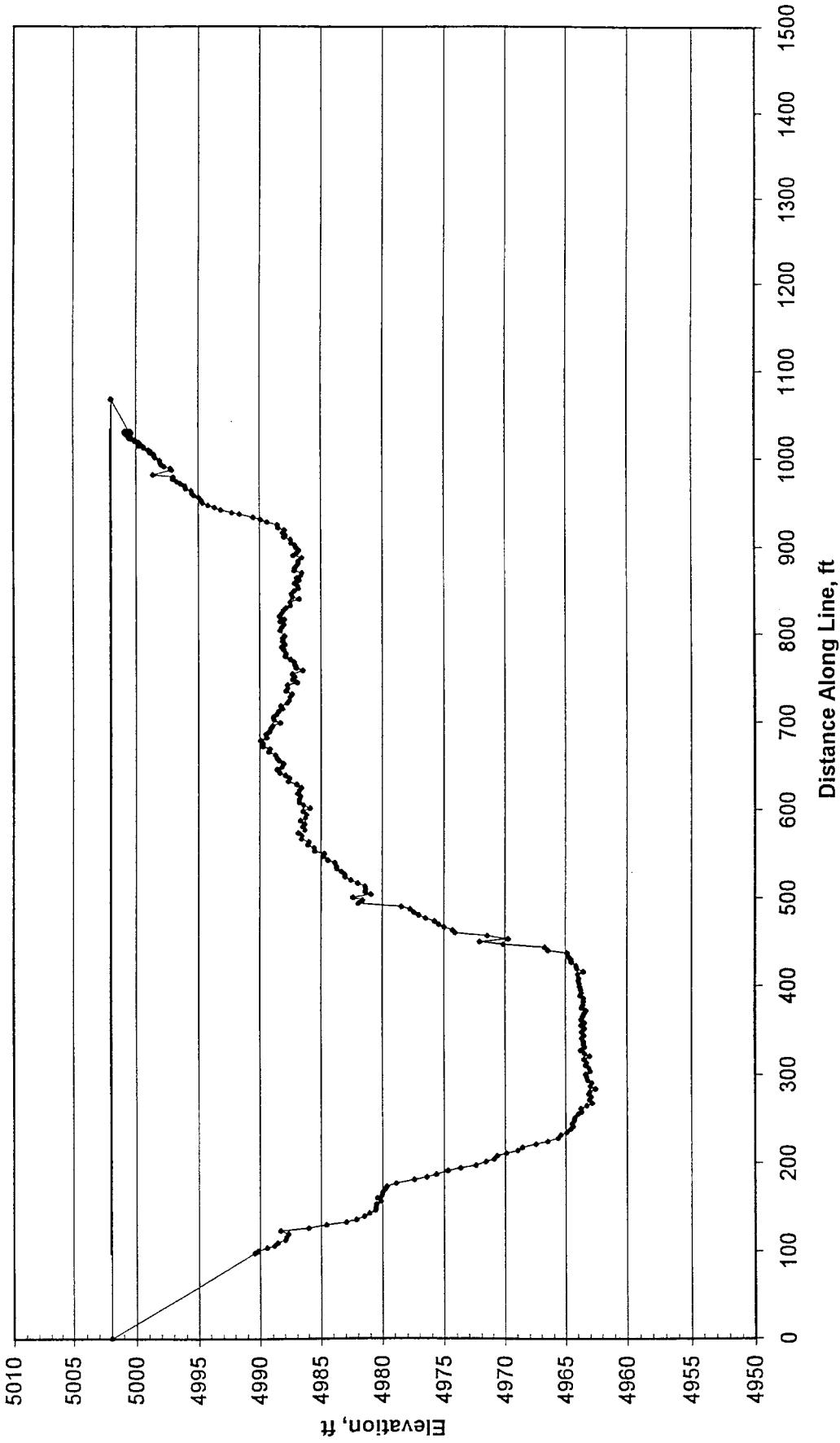
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**Southwest-->Northeast**



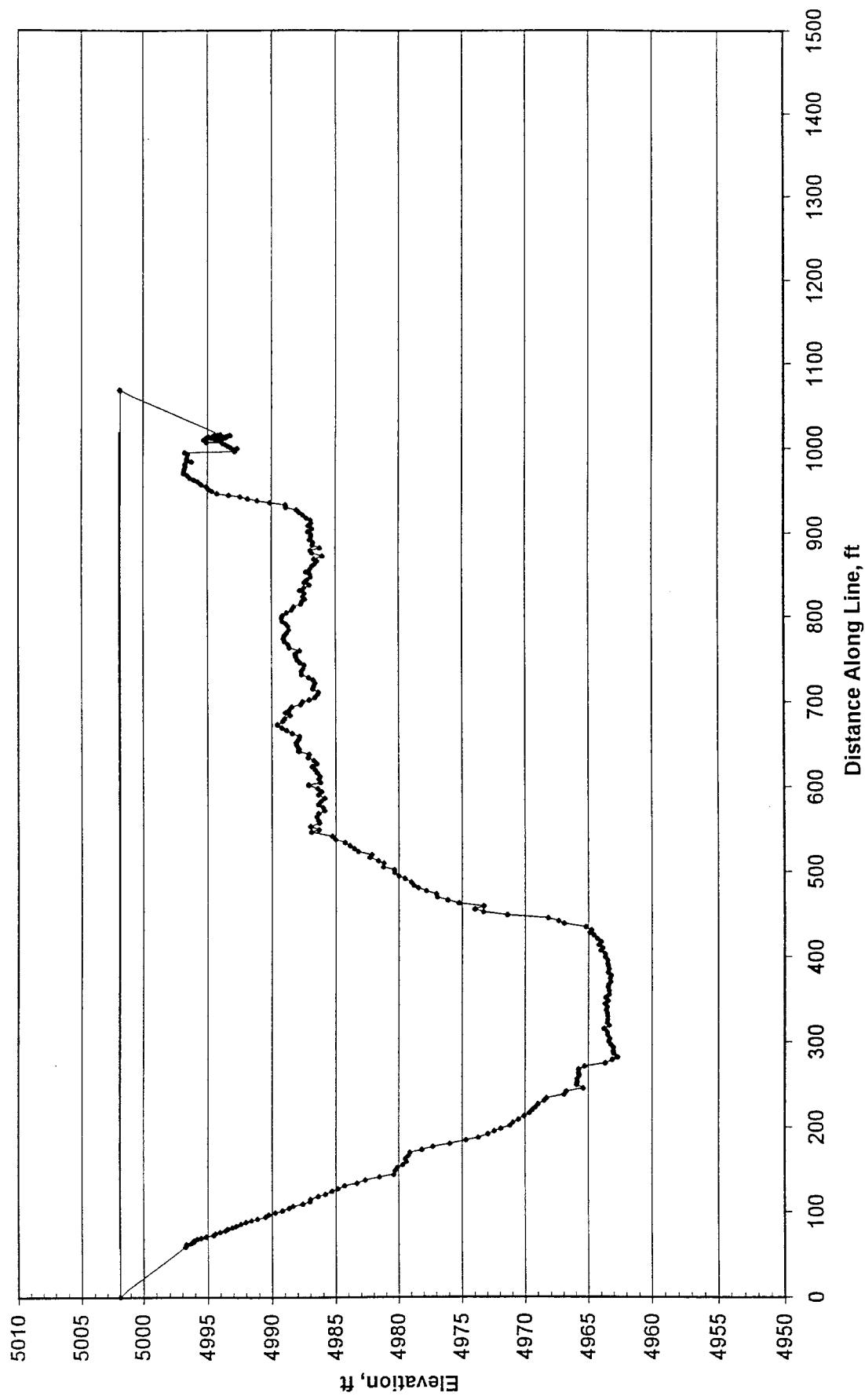
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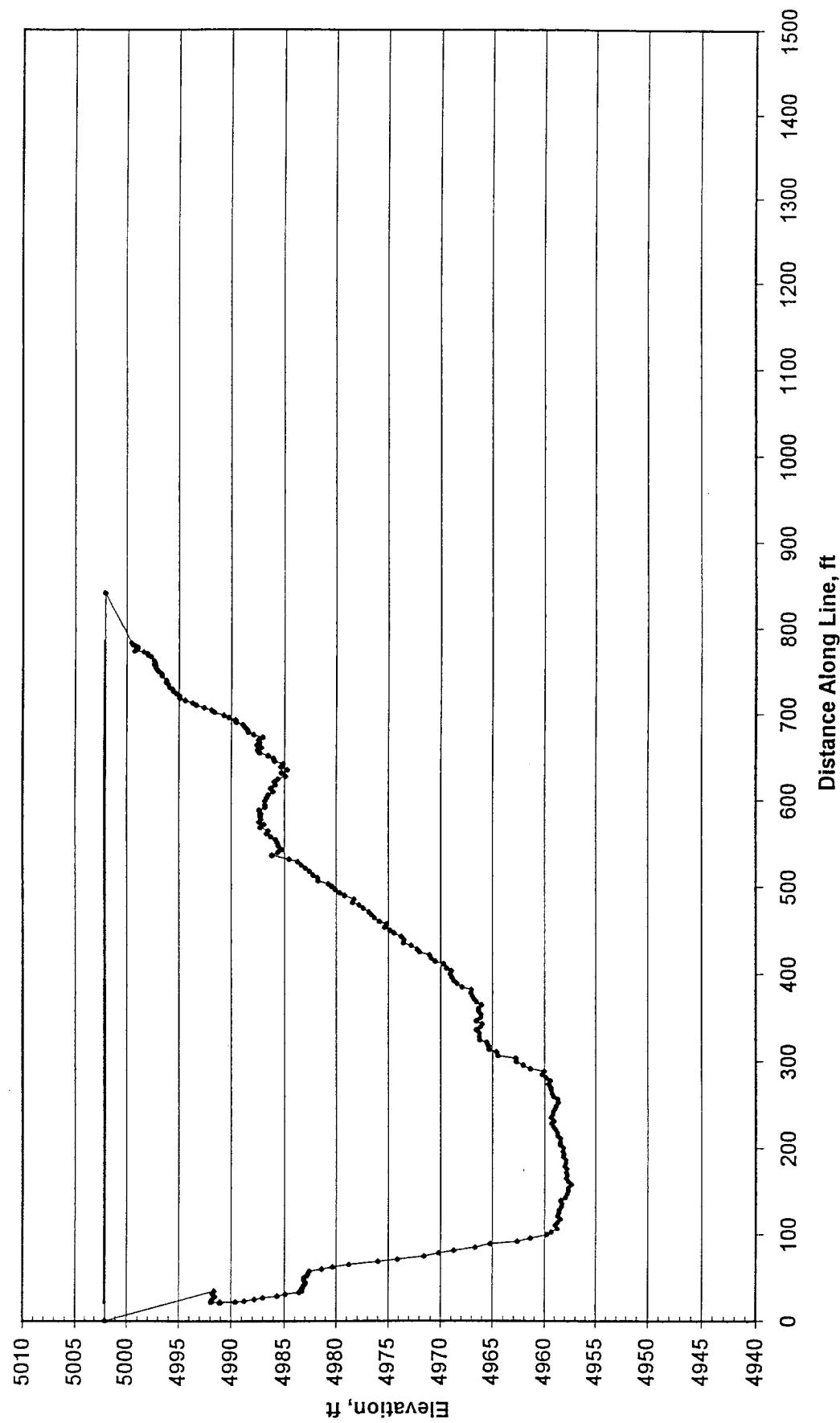
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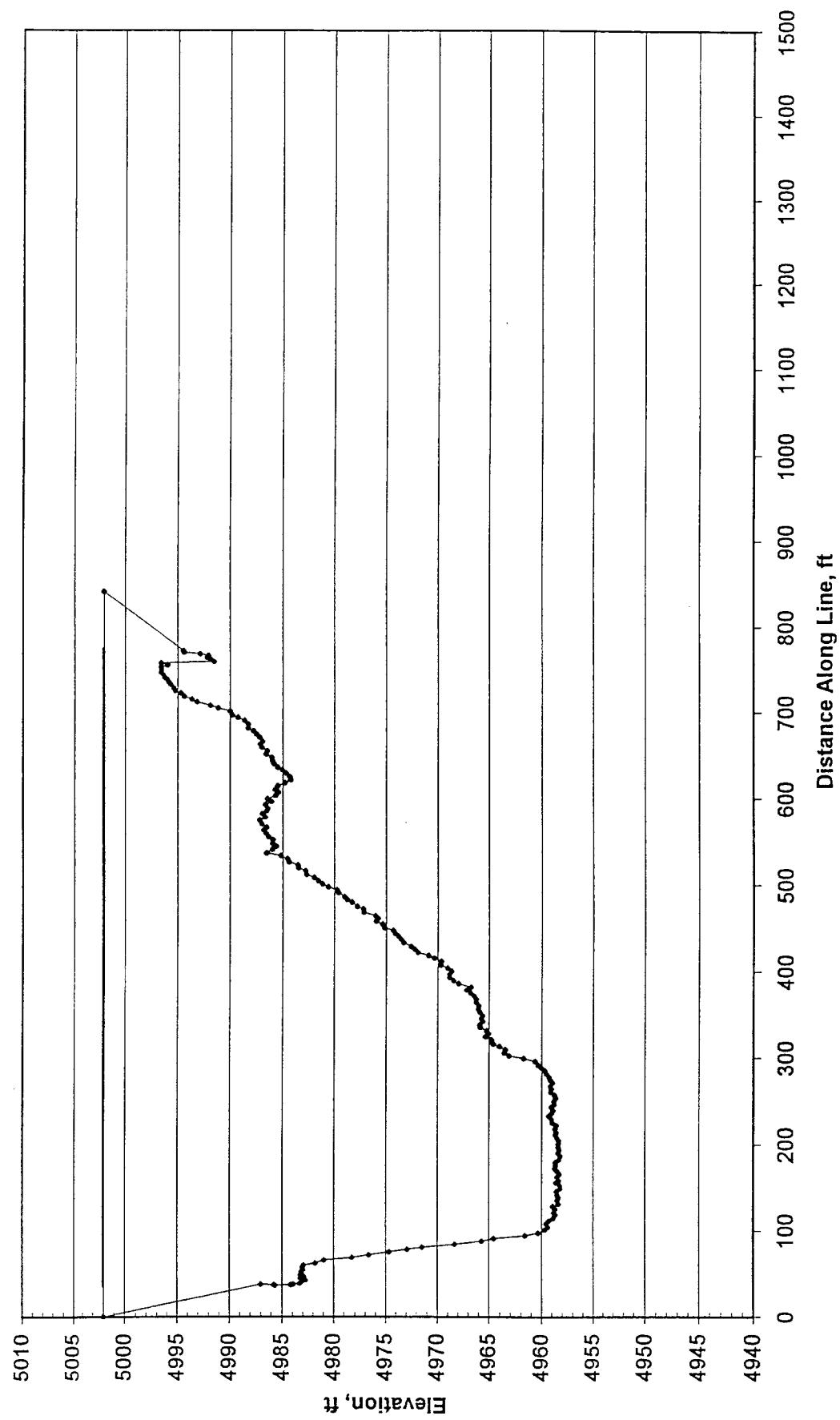
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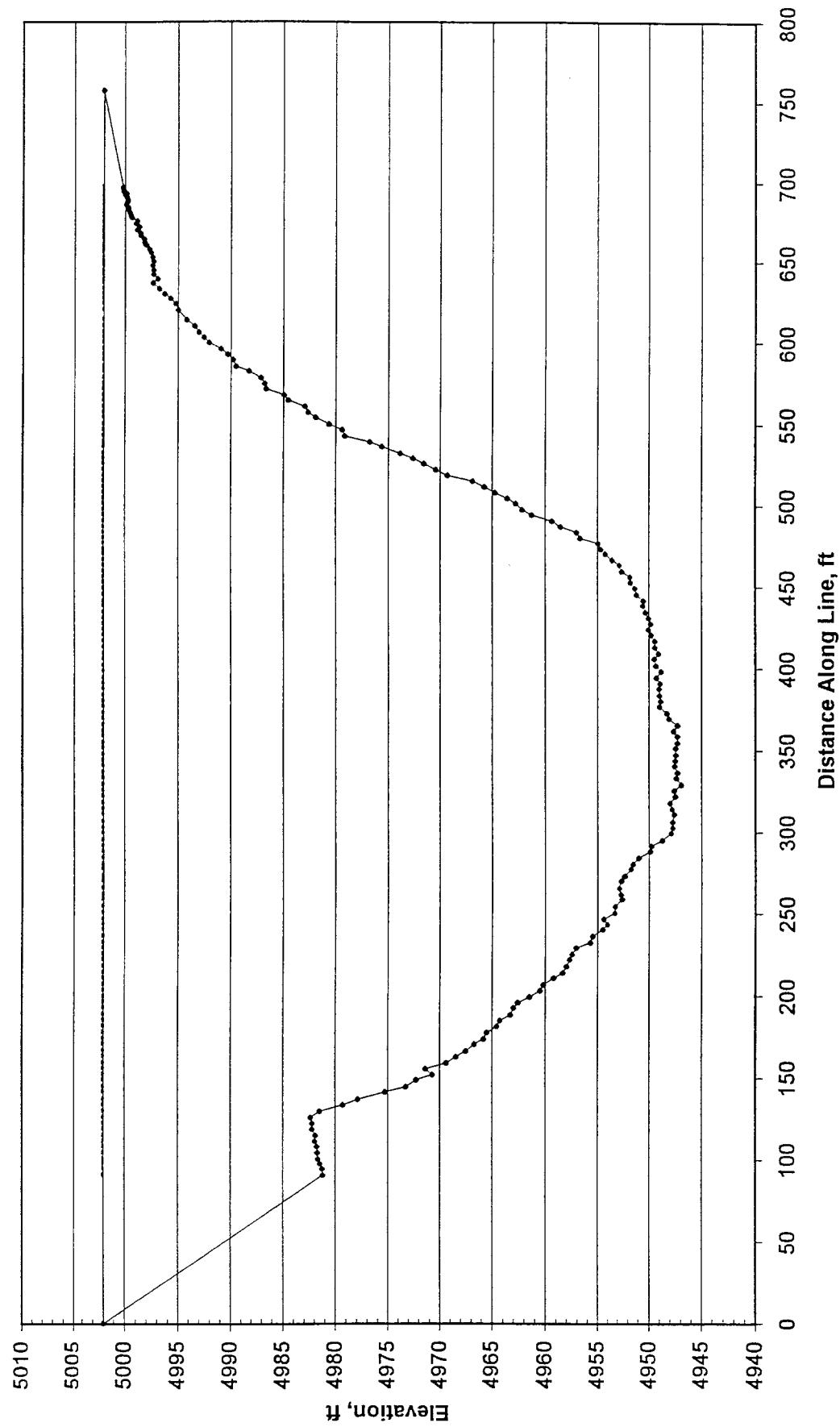
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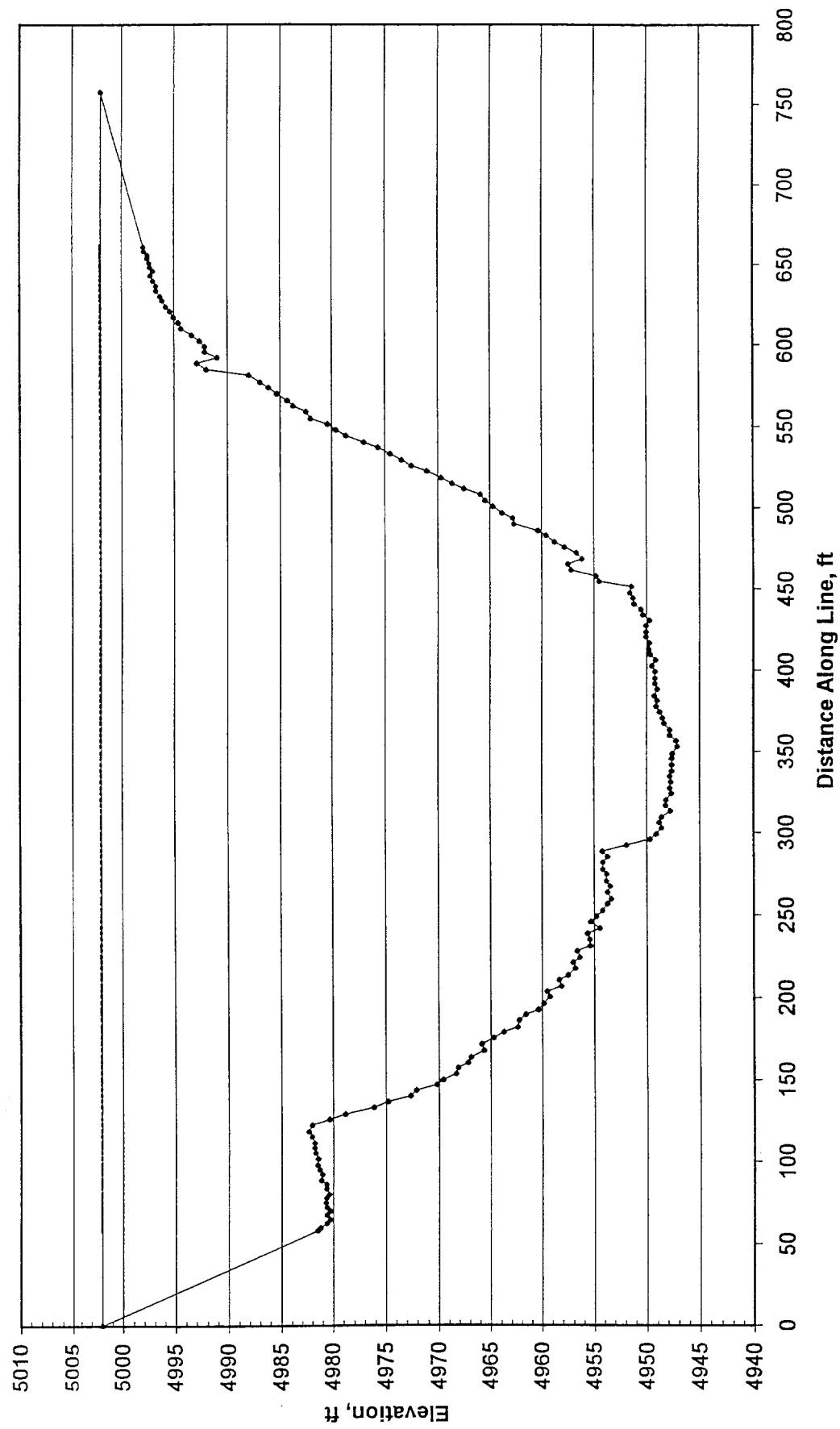
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Southwest-->Northeast



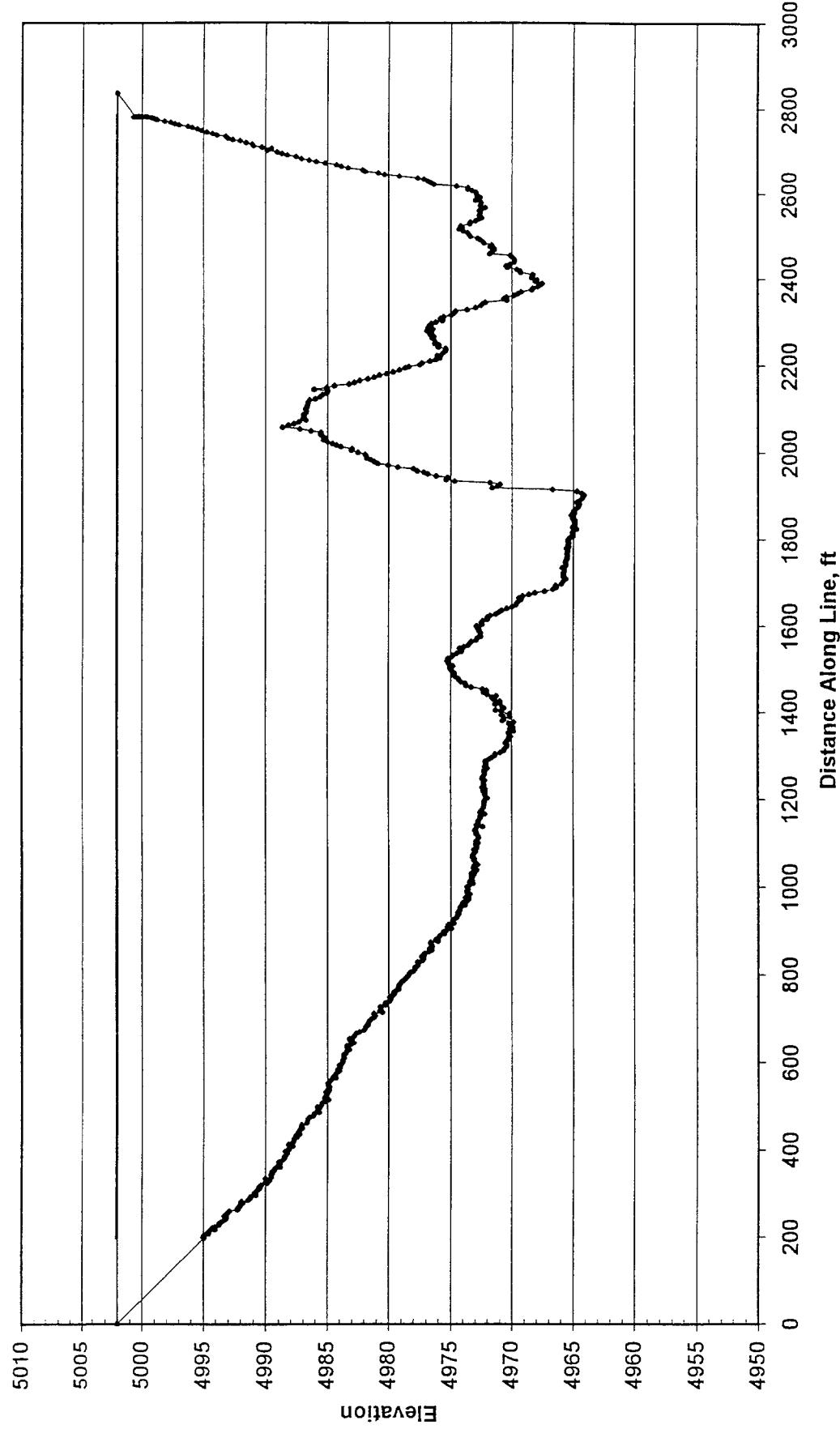
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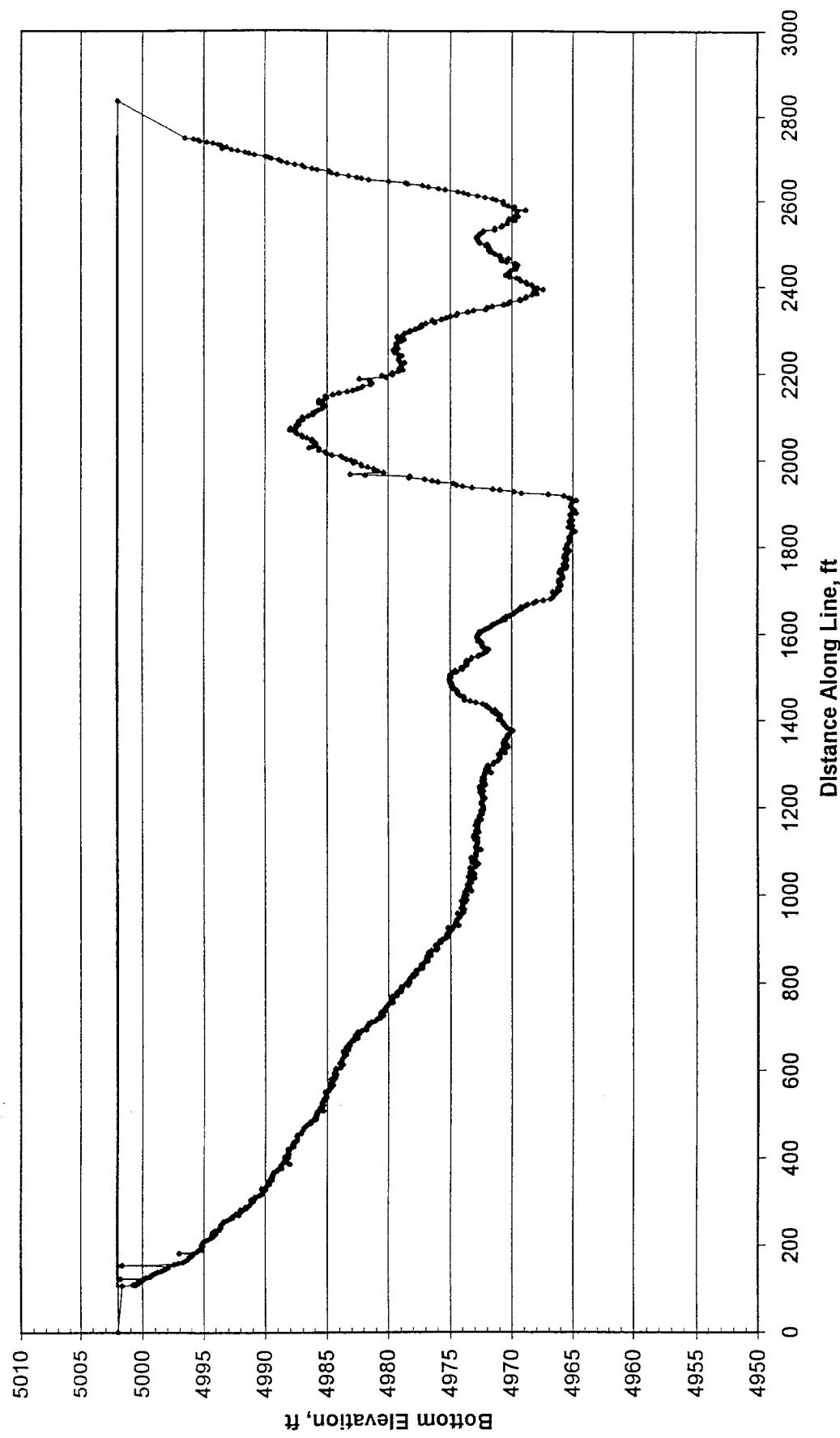
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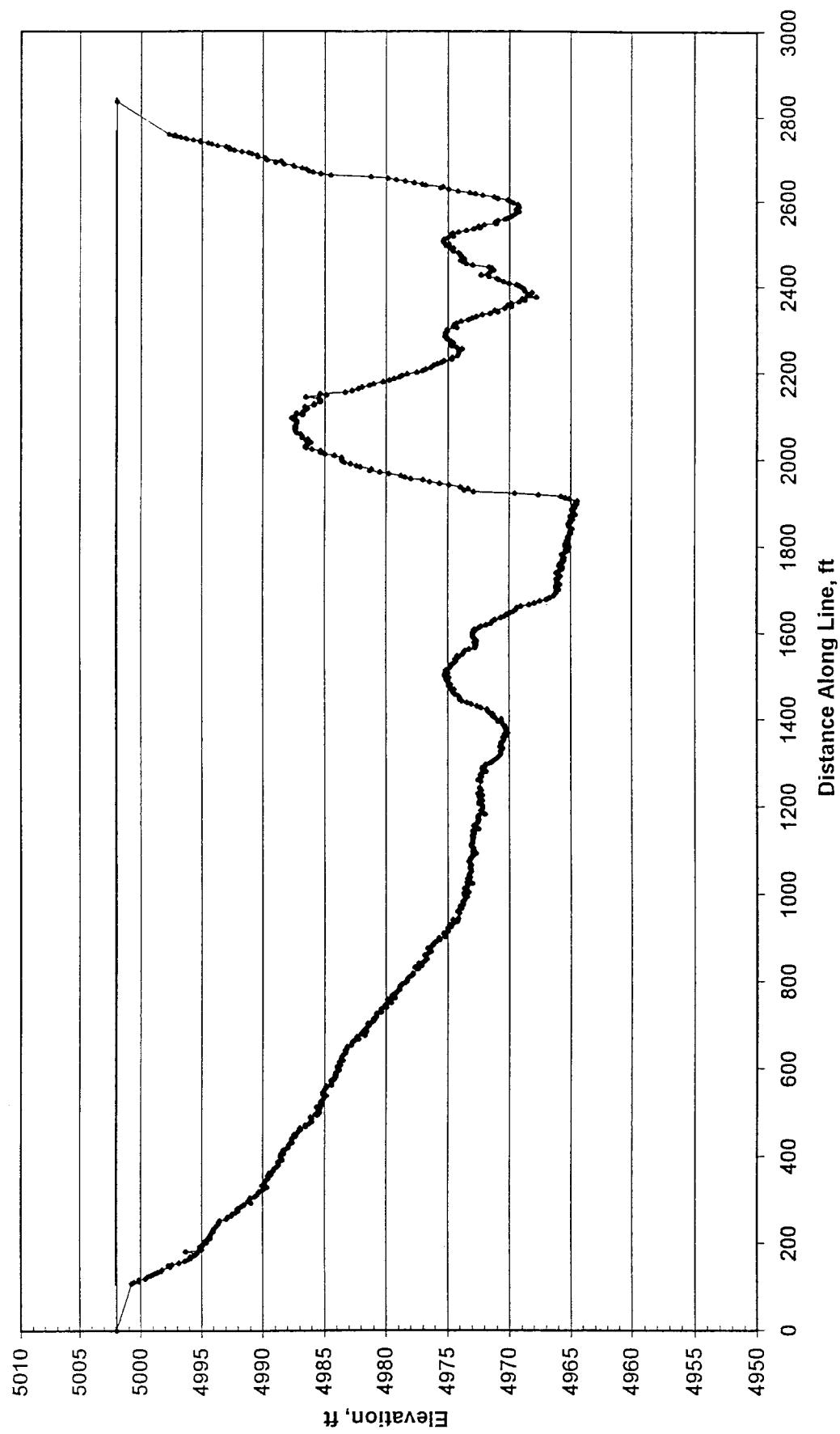
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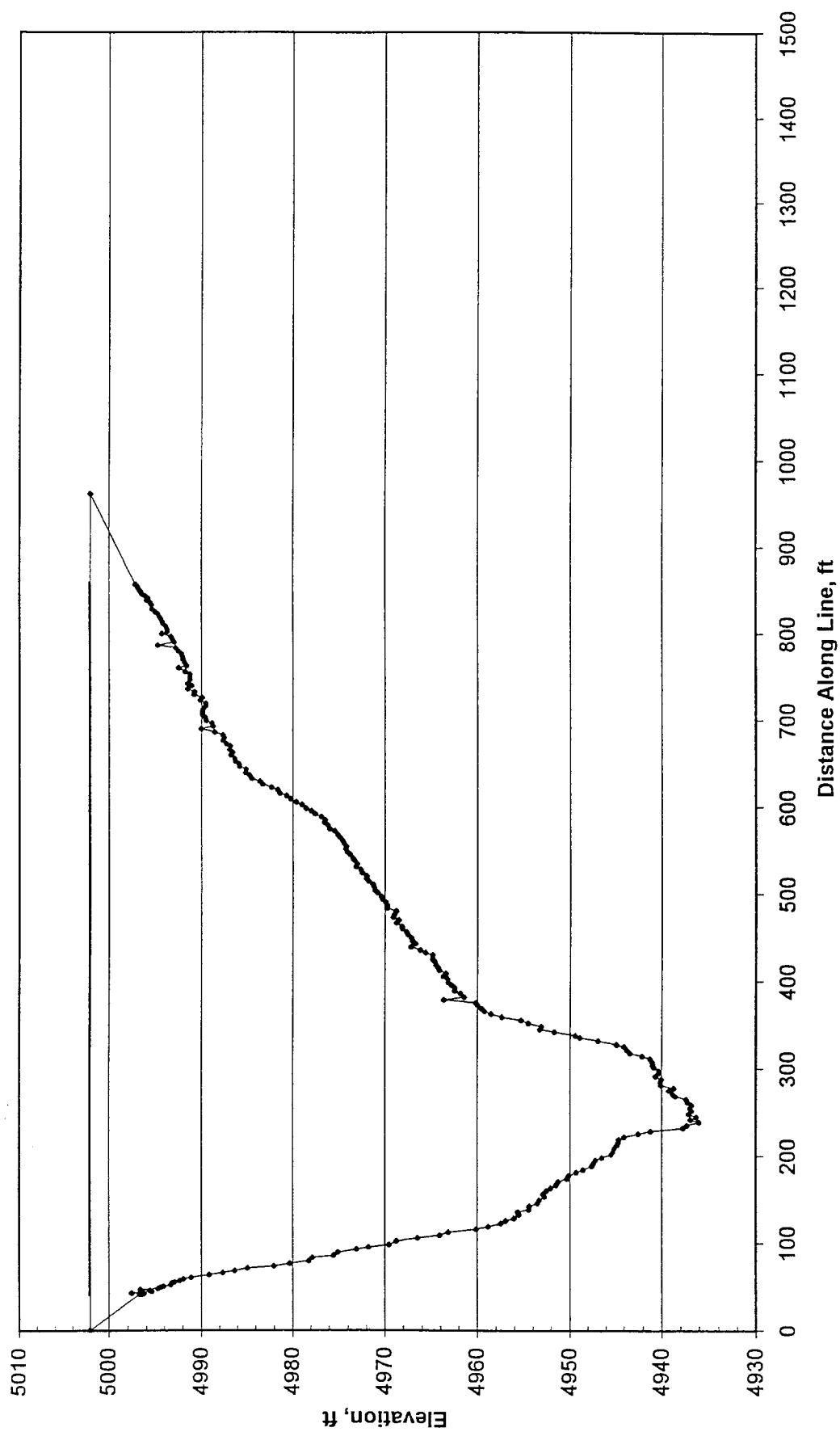
Line IC12(b) June 1998  
Northwest --> Southeast



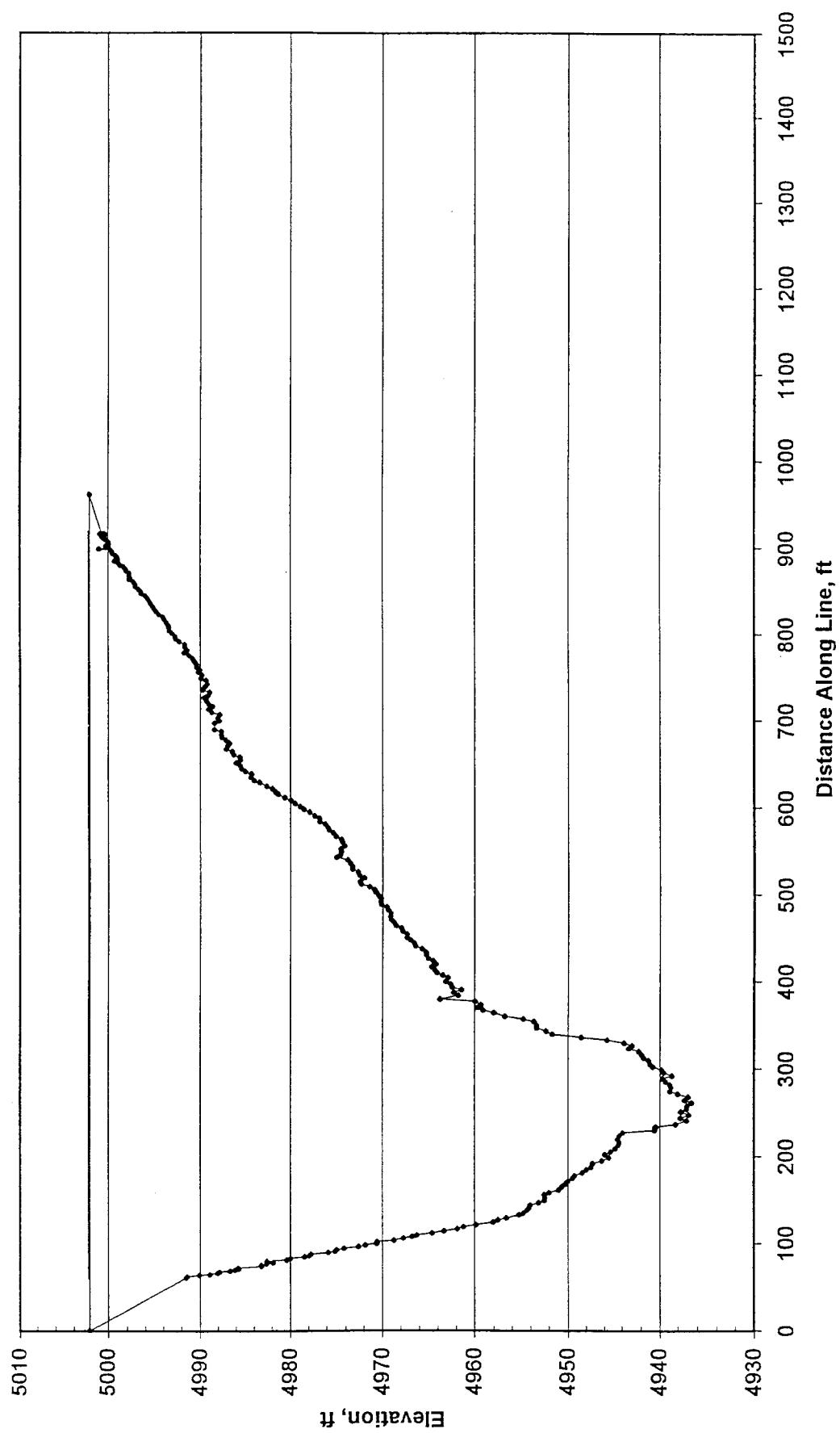
Line IC12(c) June 1998  
Northwest-->Southeast



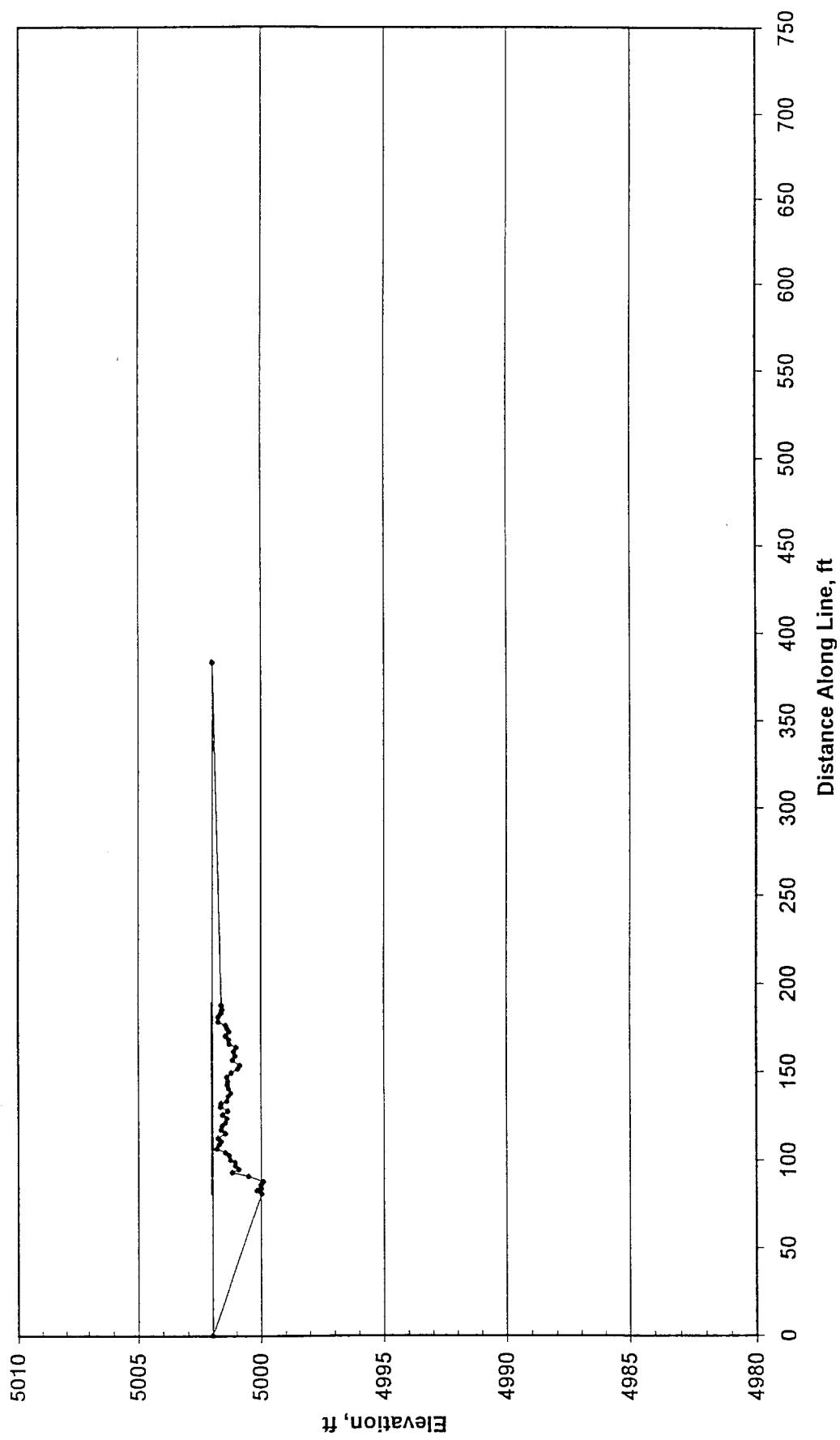
Line IC13(a) June 1998  
South-->North



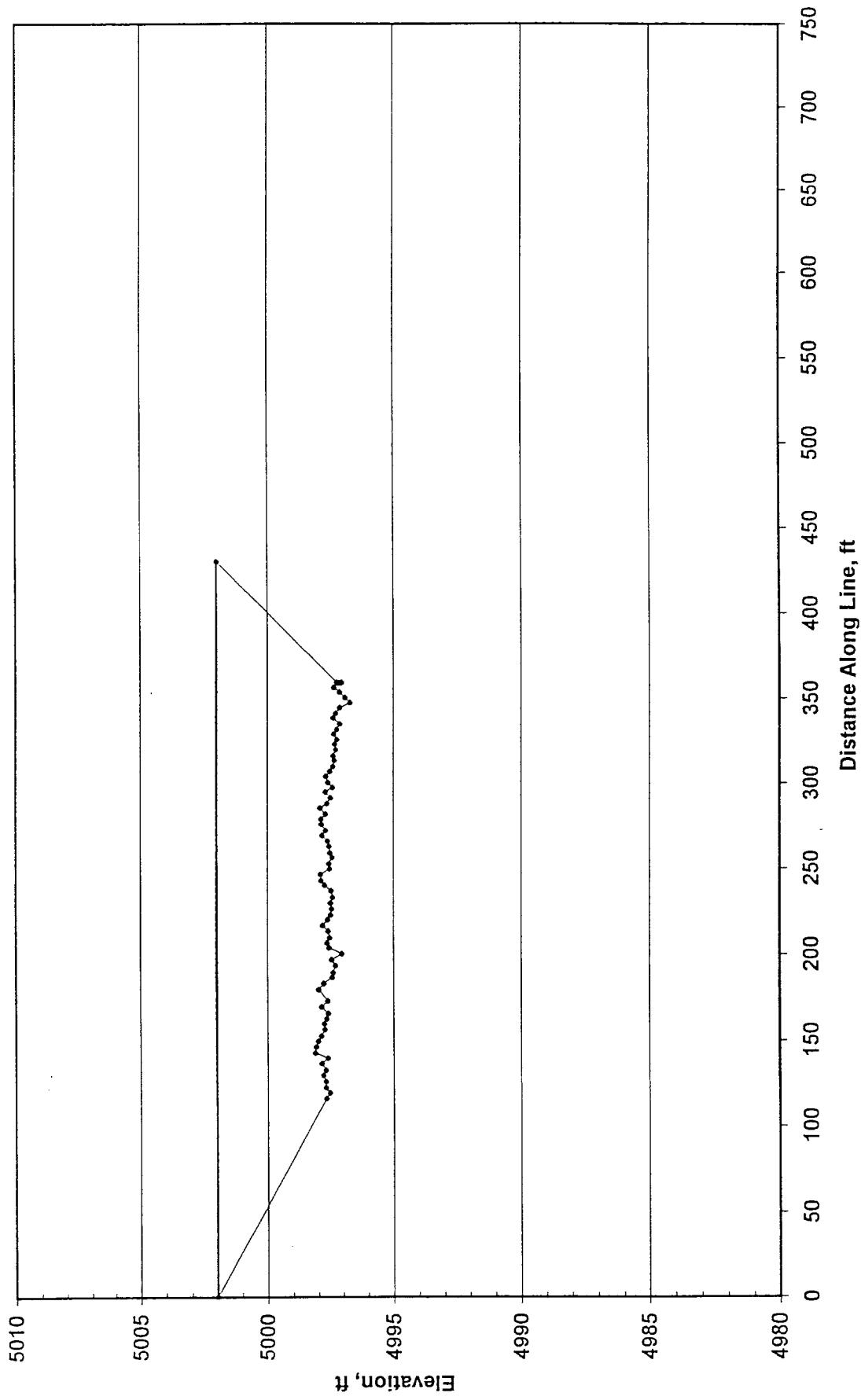
Line IC13(b) June 1998  
South-->North



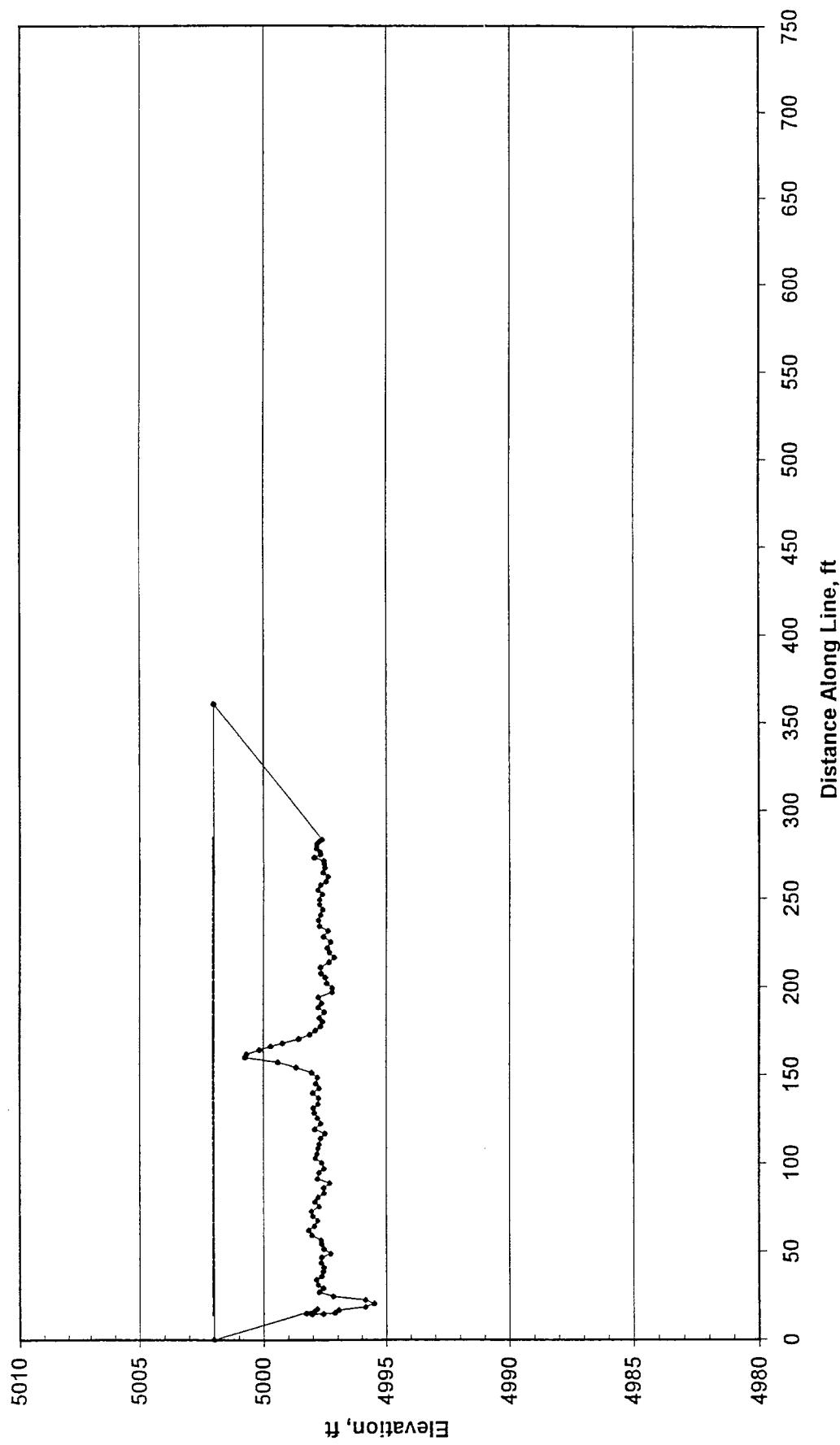
**Line L2 June 1998**  
**West-->East**



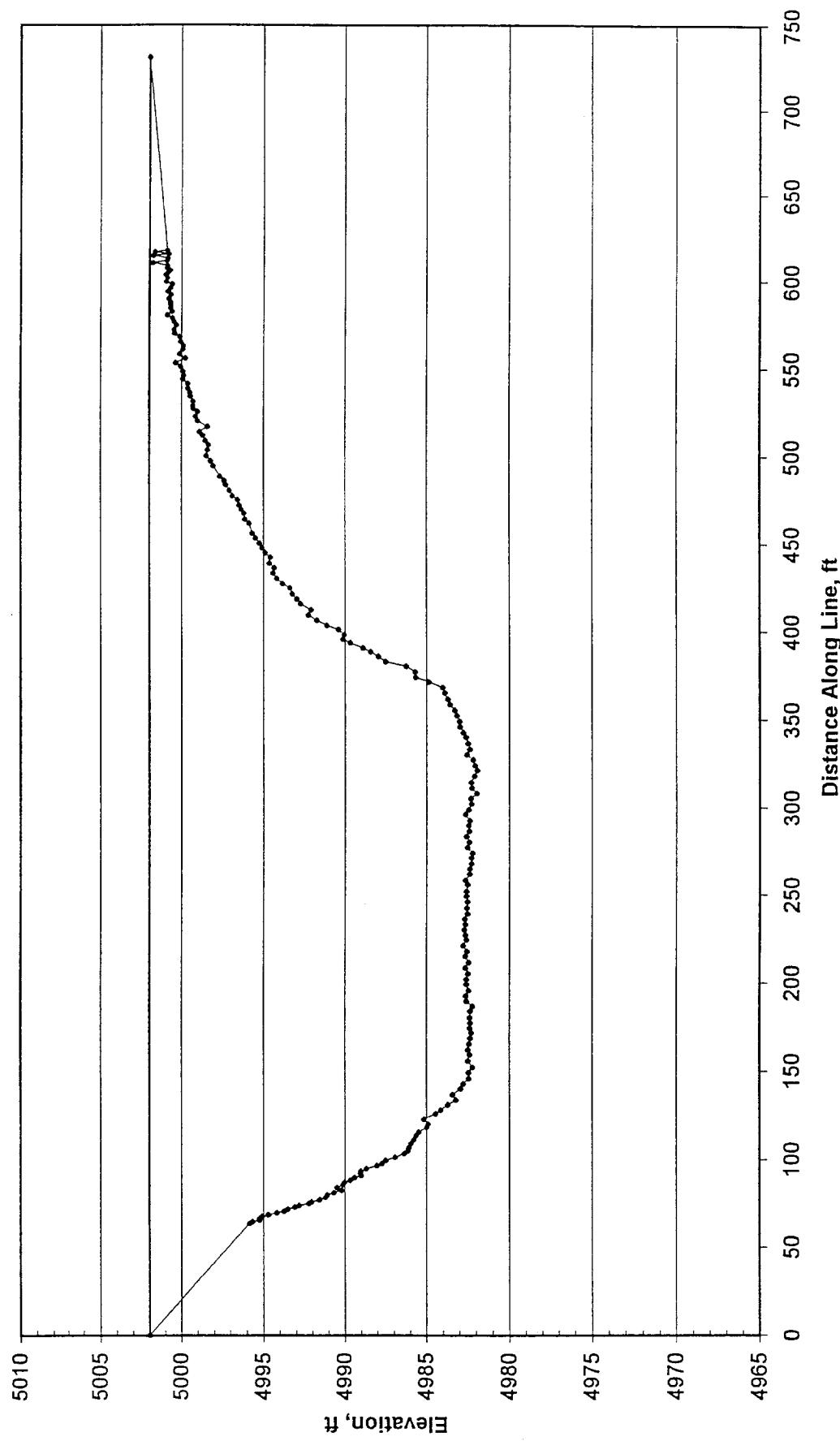
Line L3(a) June 1998  
West-->East



Line L3(b) June 1998  
West-->East



Line L4(a) June 1998  
South-->North



Line L4(b) June 1998  
South-->North

